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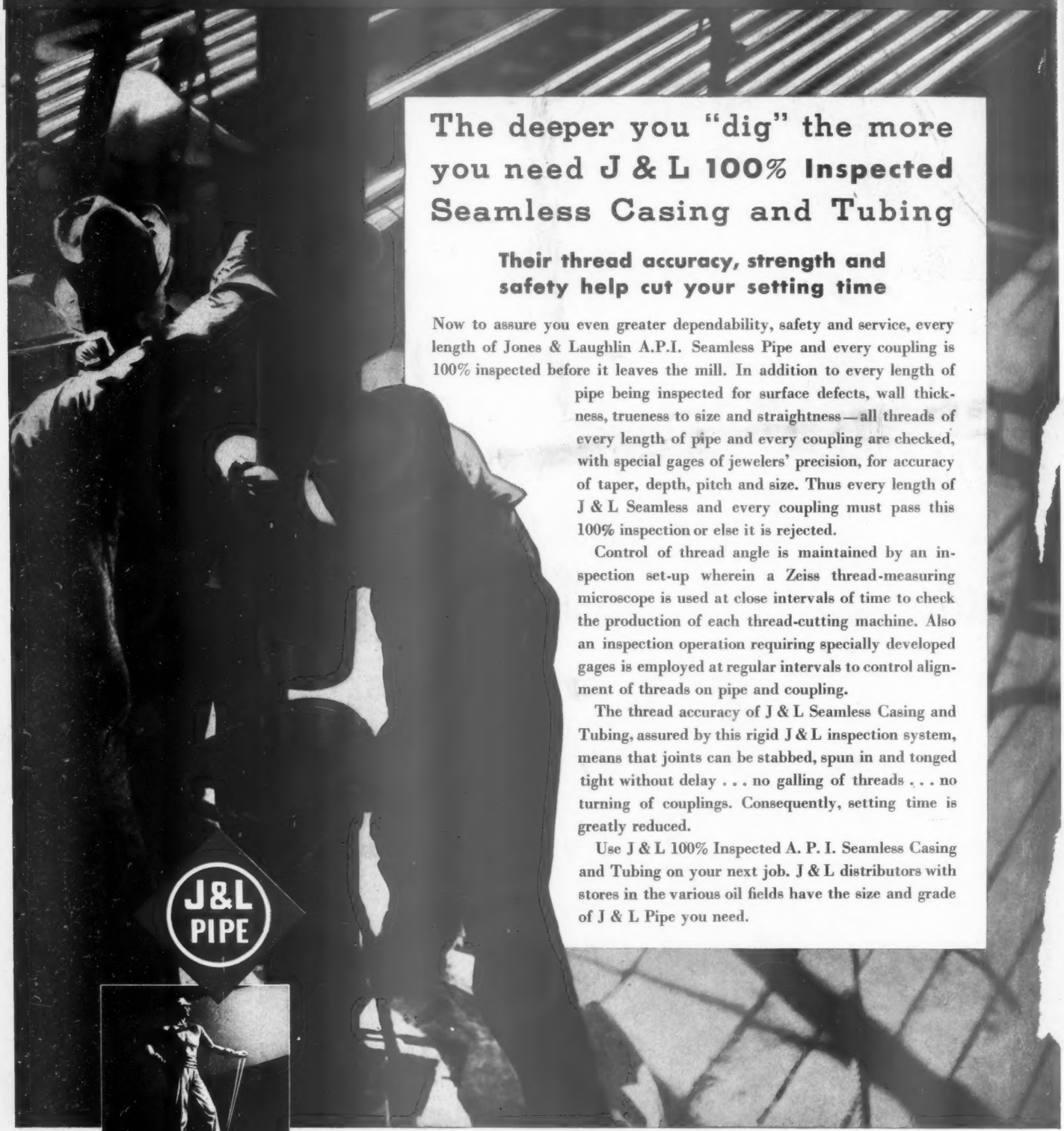

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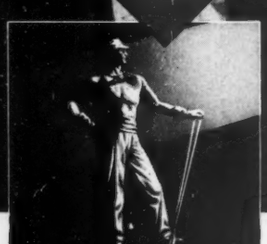

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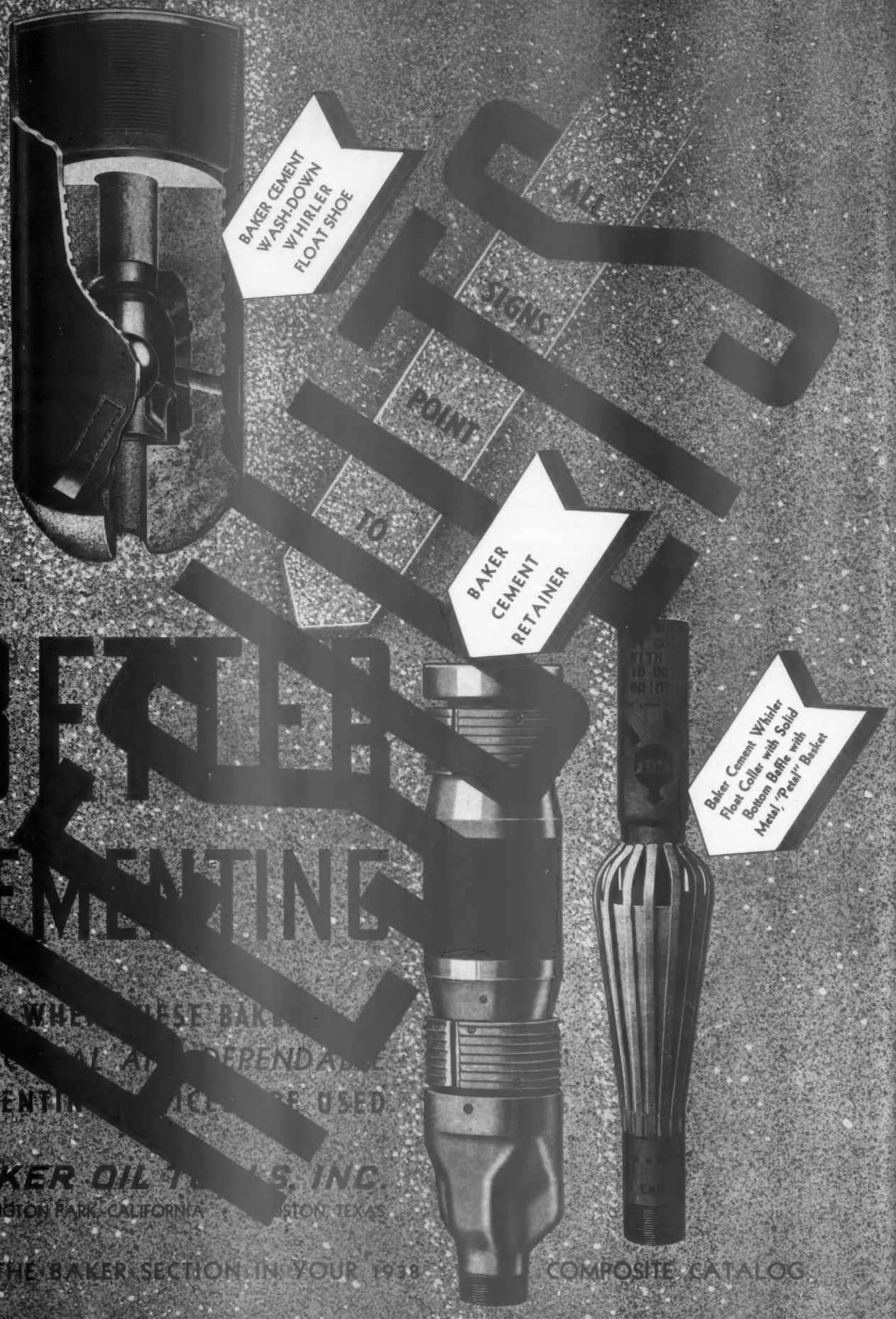
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Trends

Big Consumption Rate Causes Better Feeling in Spite of Low Prices

A PRODUCTION decrease of 395,355 barrels per day brought United States crude oil output back to normal in the past week. Production in Texas was cut 399,896 barrels per day by the resumption of the five-day production week. The efforts of the Texas Railroad Commission to find purchasers for the oil produced from about 500 East Texas wells that have no pipe line connections have met with encouraging response. Large crude buyers in the world's largest field have informed the commission that they will connect with the wells in question provided the commission continues the Saturday and Sunday shutdowns through December. If the Saturday shutdown is discontinued the additional oil load would be too large for some of the pipe lines to handle and the 500 oil wells would continue to stand profitless. The matter will be one of the subjects of discussion at the commission's proration hearing on Friday of this week.

CRUDE PRODUCTION *3,243,796 barrels daily average—down 395,355. One year ago 3,547,122 barrels.*

CRUDE STOCKS *275,824,000 barrels as of October 29—down 828,000. One year ago 307,140,000 barrels.*

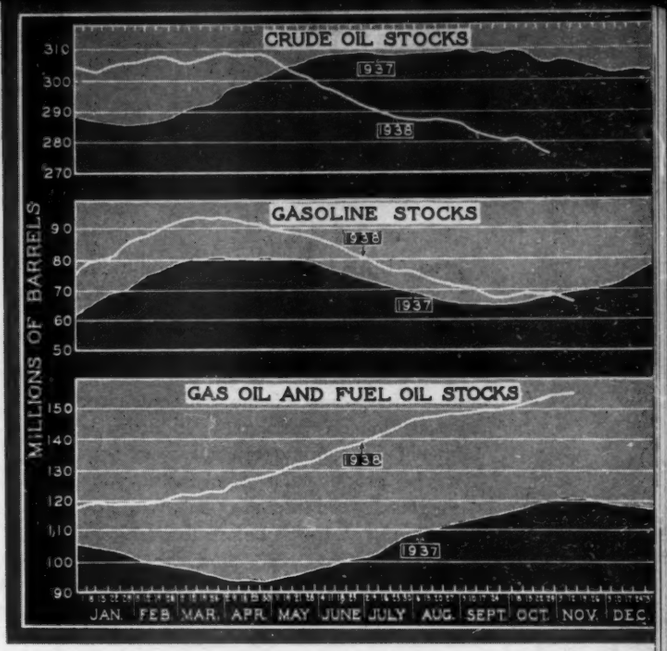
GASOLINE STOCKS *67,551,000 barrels as of November 12—down 685,000. One year ago 69,073,000 barrels.*

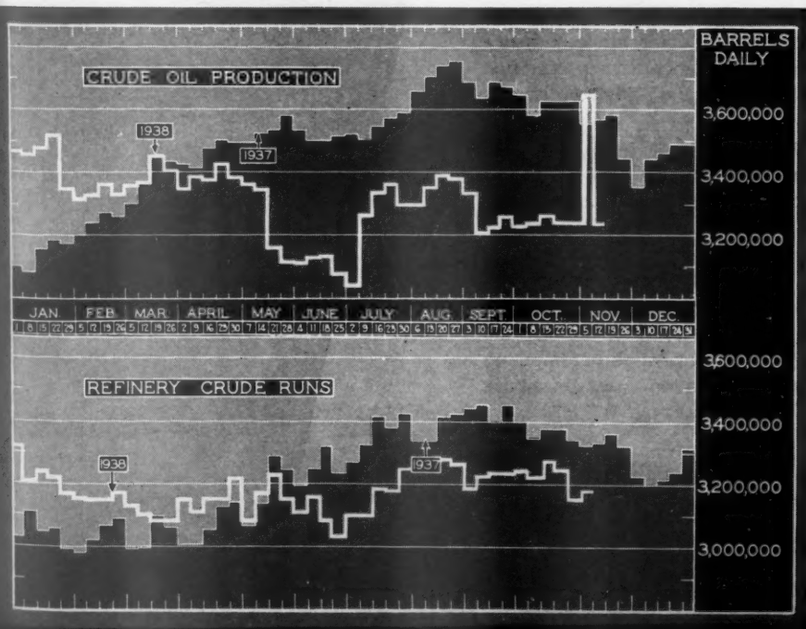
GAS AND FUEL OIL STOCKS *154,666,000 barrels as of November 12—up 90,000. One year ago 120,201,000 barrels.*

REFINERY RUNS *3,180,000 barrels daily week ending November 12—up 20,000. One year ago 3,335,000 barrels.*

The fate of thousands of stripper wells in eastern Kansas, which have been threatened with a loss of market, is still undecided. A hearing which was to have been held before the Kansas Corporation Commission last Friday, has been postponed until November 28, and the principal buyer in the oil fields will continue to run oil until that time, at least.

Insufficient pipe line facilities in Illinois in the face of a steadily rising increase in the potential production of the basin fields, leaves producers with a much curtailed market for their crude, the result of which is that some of them are selling a part of their surplus below the posted market price. This situation has not yet reached serious proportions but is said to be spreading slowly giving rise to exaggerated rumors.





Notwithstanding the abnormally low prices for many refined products, a definitely better feeling was discernible this week. It was ascribed in large measure to the high rate of gasoline consumption, disappearance of much underpriced material that had been overhanging the market, and expectation that constructive suggestions will result from the study of oil problems being made by the committee of 36. Bargain-hunters testified they were encountering increasing difficulty in getting concessions on gasoline prices. Some of the large refiners are buying regular-grade motor fuel, presumably storing most of it in anticipation of higher prices. Natural gasoline in the Group 3 territory rose a quarter-cent, establishing a better balance with the market in Texas, where material had been seeking outlets. The same mild weather that has prolonged the motoring season and kept gasoline movement at high tide continues to retard demand for light fuels, and in some areas there has been a softening of these products. Accelerated demand for heavy industrial fuels was reported.

DAILY AVERAGE PRODUCTION FOR WEEK

	Nov. 12, 1938	Bur. Mines Nov. est. of demand	Nov. state allowables	Nov. 5, 1938
Oklahoma City	105,275	.....	.....	88,075
Fitts	37,075	.....	.....	38,350
Remainder of state	308,350	.....	.....	310,550
Total Oklahoma	450,700	515,000	428,000	436,975
East Texas	370,400	.....	.....	518,447
West Texas	201,449	.....	.....	266,599
North Central Texas	107,198	.....	.....	111,550
Texas Panhandle	58,850	.....	.....	82,496
East Central Texas	88,650	.....	.....	109,398
Gulf Coast Texas	331,750	.....	.....	432,950
Southwest Texas	96,897	.....	.....	133,650
Total Texas	1,255,194	1,371,000	1,279,653	1,655,090
North Louisiana	71,590	.....	.....	76,750
Gulf Coast Louisiana	189,150	.....	.....	191,550
Total Louisiana	260,740	256,300	235,000	268,300
California	667,100	616,700	610,000	657,200
Kansas	148,075	164,300	163,400	144,600
Arkansas	49,370	52,300	52,000	49,215
Eastern Fields	93,000	98,100	.....	92,710
Illinois	86,604	64,300	.....	99,060
Michigan	51,173	50,300	.....	54,271
New Mexico	109,760	111,000	105,400	109,770
Rocky Mountain area	72,080	92,000	.....	71,960
Total United States	3,243,796	3,391,300	.....	3,639,151

15 Minutes

CAUSES behind ills of the oil industry were aired at the opening and following sessions of the American Petroleum Institute directors attending the annual meeting at Chicago. Blame for some of the ailments was placed on the purchasing policies of some of the leading crude buyers who are also producers in most instances.

Directors and invited guests who had opportunity to speak before the sessions used names and also cited specific instances and examples.

The discussions were the most spirited heard before the A.P.I. board in years. Most of the complaints were from independent producers, who felt the crude cut of September and early October was unjustified in view of storage withdrawals averaging more than 80,000 bbls. per day so far this year, and in view of the lack of consistency on the part of purchasers who are also producers. Examples cited of disparity included allowables of 600 bbls. per well in a certain Louisiana district while thousands of Texas wells are curtailed to the marginal of 20 bbls. per day per well and that allowed on a five-day producing week basis. Further examples of frequent reductions in allowables and withdrawal of pipe line connections in other parts of the Mid-Continent were also cited in a general review of the conditions now existing.

I.P.A.A. Active

A study of pipe line divorcement, disintegration, refinery control through machinery similar to the Interstate Oil Compact, expansion of the Connally Act to include stipulation of maximum quotas and appointment of an "umpire" was presented before the A.P.I. board by members of the Independent Petroleum Association's Committee of 36, headed by Wirt Franklin, which held sessions across the street from the A.P.I. headquarters throughout the week.

Speakers representing each of the large producing divisions in the Southwest reviewed actual conditions as they now exist with regard to production allowables, pipe line connections and exploitation programs. Conditions were discussed by the following speakers:

Charles F. Roeser, Roeser & Pendleton, Fort Worth, Tex., and Burdette Blue, Bartlesville, Indian Territory Illuminating Oil Co., on Oklahoma; Jake L. Hamon, Dallas, Cox & Hamon, on Louisiana; E. B. Shawver, Wichita, independent producer, on Kansas; George A. Hill, Houston, Houston Oil Co., on Texas; Mr. Franklin, Ardmore, Wirt Franklin Petroleum Corp., on Oklahoma, and W. S. S. Rodgers, New York president of the Texas Co.

Directors adopted by rising vote a resolution in memoriam for the late Frank R. Coates of Cities Service, who was a director of the A.P.I.

The well spacing committee report submitted by Mr. Hill, chairman, was received and the review indicated that some progress is being made in eradicating practices violating the engineering theories of conservation.

Directors authorized the executive vice president and the secretary of the A.P.I. to execute a deed transferring to the commonwealth of Pennsylvania title to nine acres of wooded land for enlargment of the Drake Memorial Park near Titusville.

Through Tuesday evening's count, the official registration was 1,912, an increase of 200 over the comparable figure for the preceding year's annual meeting.

There is no uncertainty regarding the attitude of leaders toward federal control. They point out that the petroleum industry is manufacturing 1,800 million dollars worth of its products this year, that these will be higher in quality and lower in price than they were 10 years ago, and that no other basic industry can present such a record with reference to commodities of every-day family use.

President's Address

In the president's address before the first general session, Axtell J. Byles recommended membership of all oil-producing states in the Interstate Oil Compact and continuance of the compact itself by federal and state approval. He emphasized the importance of making the Connally Act permanent and of enacting adequate conservation laws in states now lacking them.

"Under proper conservation practices," President Byles said, "much narrower swings in the price trend are likely to occur than were experienced prior to production under proration. Let me say by way of illustration that something like a 5- or 10-cent increase or decrease in the price of a barrel of crude oil, rather than violent fluctuations upward or downward, probably will be a logical and wholesome development resulting from the proration system."

Commenting on future developments, Mr. Byles said that with crude oil and gasoline inventories sound, the only really burdensome inventory conditions remaining are those relating to residual fuel oil and lubricating oils. This situation would be relieved by a continued business pick-up. The oil industry, during the past summer, liquidated excesses of the previous year to a large extent and should look forward to an improved position in 1939 if it is not burdened with uneconomic inventories on March 31.

In considering measures affecting the future progress Mr. Byles said it was im-

W. R. BOYD
Executive Vice President

with the A. P. I.

portant to recognize frankly what "is right with the industry."

In a plea for "this great industry to stand firm in defense of the American system of free and competitive enterprise," J. Howard Pew declared: "No economic planning authority could ever have foreseen, planned, plotted, and organized such an amazing spectacle of industrial progress as the world has witnessed in the last century. No trust or combination, private or governmental, could have accomplished it."

Mr. Pew pictured the petroleum industry both as the nation's largest single industrial undertaking, and as "our most impressive monument to the efficacy of unstinted competition."

"We cannot but view with concern the tendency of government to control more and more of industry and thus continually to narrow the field that is left open to free enterprise," he said. "This persistent effort to bring industry, business, commerce, enterprise, under government domination is a flat denial of all the lessons of the century and a half of the industrial age."

AXTELL J. BYLES
President

In an address which concerned itself particularly with the relation between government and business, Donald R. Richberg, formerly chairman of the National Recovery Board, said a practical program to preserve a system of free enterprise will not be found in any centralized political control of business.

Refining

Interest in the manufacture of high antiknock motor fuels was apparent throughout the meetings of the refining group though no papers were presented on this specific phase of refining. It was manifested especially in the discussion following papers on cracking. The desire to produce motor fuels of higher octane value was evident, but opinions expressed indicated that this must be done at little added cost. Particular attention was given to any suggestions regarding reduction of cracking costs, and one of the most interesting contributions offered was that of W. F. Court in which he described a method for removing coke by the use of high-pressure water and a special turbo-nozzle. In describing an installation of Dubbs cracking units at Wood River, Ill., Mr. Court said comparison of actual results obtained by cable and hydraulic systems revealed a reduction in clean-out time of at least 50 per cent in favor of the hydraulic system, with 67 per cent a frequent occurrence.

In another paper R. J. Diwoky described a system of "delayed coking" by which his company is effecting large savings in cracking operations. In this system the hot charging stock completes the cracking operation in one of a series of vertical drums.

The Houdry cracking processes were described by Eugene Houdry, who gave them their name. These processes comprise complete catalytic operations for producing motor fuels and aviation gasolines by cracking gas oils, residuums, and crude oils either with or without simultaneous production of fuel oils, and permit the use of a far wider variety of crude oils.

Interest in the paper was probably stimulated by recent announcements that three units are in operation and 10 large additional units are now under construction, representing a $24,000,000 investment by Socony and an $11,000,000 investment by Sun.

Discussing the antiknock and mixture distribution problem in the multicylinder engine, a paper by A. J. Blackwood, O. G. Lewis, and C. B. Kass asserted that present-day cars are not capitalizing on the continued efforts of the petroleum industry to provide fuels of better volatility and higher octane number.

E. A. Burch, J. W. Donnell, L. L. Davis, and Anton Nelson presented four papers on laboratory and pilot-plant methods of controlling the quality of wax distillates developed and used by Continental Oil Co. and a survey of five Oklahoma wax distillates by the Chemical Engineering Department of the University of Oklahoma.

Corrosion Problems

J. A. Jamison discussed corrosion problems in refinery equipment and methods of protection. Numerous examples were included to show the specific effect of commonly used remedial measures.

R. H. Hubbell, Jr., and R. P. Ferguson discussed the results of their investigation of the effect of continued revivification on the adsorptive qualities of bauxite.

Dr. Frederick D. Rossini said that five years of laboratory research work on the chemical constitution of the lubricant fraction of Mid-Continent crude oil is contributing to knowledge of what kinds of molecules constitute lubricating oil, thus making it possible to learn what molecules should be synthesized. He said the data will be helpful also in solving the industry's problem of producing, from the lubricant fraction of petroleum, materials of special properties which better can fill modern requirements arising from

This summary was prepared by the following members of The Oil and Gas Journal editorial staff: W. T. Ziegenhain, L. G. E. Bignell, Dr. C. K. Francis and H. Stanley Norman.

E. L. DECKER *F. E. BARTELL* *D. R. RICHBERG* *E. W. GARD* *R. H. HUBBELL, JR.*

the need for greater efficiency, higher speeds more concentrated power, and the use of high pressures and high and low temperatures.

C. M. Ridgway, L. M. Henderson, and W. B. Ross gave the results of their study of the recovery of oil from spent percolation filters.

The central and general refining committees discussed a proposal that vocational training courses be established for refinery employes similar to those in the producing division.

Production

Emory Kemler discussed factors influencing the application of pumping units, pointing out conditions bearing upon the efficiency of various mechanical methods of producing oil and incorporated formulae to demonstrate how mathematics might be applied in the solution of these problems.

The welding of casing is rapidly gaining recognition in the production division of the industry and one of the principal advocates of this practice is L. R. Hodell, who presented a paper on the suitability of several casing steels for field welding. This paper contained results of numerous tests and mathematical formulae to be applied in making selections of pipe suitable for welding for various purposes.

E. L. Decker gave a paper on care and maintenance of instruments used on drilling rigs. He was assisted in the preparation of the paper by N. L. Dorn.

Multicylinder gas engines are used extensively in California and elsewhere for oil-well pumping, stated James McNeill. Operating and maintenance costs of engines in pumping service for one California company were presented.

Dr. D. L. Katz, in a paper on subsurface sampling discussed various methods of getting representative samples of gas and oil as they occur at the bottom of the well. This is an important item in estimating reserves and determining well performance. With recently developed sampling devices it is possible to get reliable samples of the production opposite the formation.

A report of the Pump-Performance Experiment Committee was presented by M. G. Arthur and E. K. Parks.

The nature and importance of surface forces in production of petroleum were discussed in a paper by F. C. Benner, W. W. Riches, and F. E. Bartell. With advanced study of physics as applied to hydrocarbons underground under relatively high pressures and temperatures, many new facts are being brought to light which indicate the probable action of these elements as they leave the reservoir.

This same subject was discussed further by B. H. Sage, B. L. Hicks and W. N. Lacey, in their joint paper on partial volumetric behavior of the lighter hydrocarbons in the liquid phase. These research engineers studied the behavior of mixtures of gas and oil under high pressures. By using their findings much can be done in the application of the data to production problems involving deep-seated formations where the hydrocarbons probably exist in vapor form until pressures are reduced.

More than 30 committees and 25 subcommittees of the Division of Production held meetings at which oil-country pipe standards were discussed and recommendations made. Round threads for tubing were recommended and much was done to clarify grading of pipe.

The Special Committee on Well Spacing discussed many phases of this subject. The Topical Committee on Drilling Practice heard reports on California, Mid-Continent and Permian basin practices and a discussion of sampling and the logging of wells by mud analysis. Slim hole drilling was considered.

The Topical Committee on Production Technology made a report to the main committee after a meeting at which this subject received careful consideration. The need for uniform practices and terms was emphasized.

Pipe Line

Papers on pipe line practice were presented by J. M. Pearson, on the value of soil-survey methods, and by Walter F. Rogers, on the use of rust-hole records to study pipe service.

Available facts on tank evaporation losses were correlated and compared in a paper by C. C. Ashley. Mr. Ashley reaches the conclusion that much of the data already published is not comparable because there has been no common basis for comparison. Methods of presentation used have not included enough of the many variables affecting evaporation losses to insure results which are truly representative or comparable. Several graphs and charts were presented, based upon vapor pressure of oil at average temperature of oil in tank, which in the author's opinion is an adequate factor to be used for comparing evaporation losses.

Another paper along this same line was presented by Louis Bosa, on the calculation of venting requirements for low-pressure oil-storage tanks.

Public Relations

Recommendations of the recently reorganized Public Relations Committee, of which W. S. S. Rodgers is chairman, were drafted at a closed meeting and later submitted to the directors for final consideration. The program looks to wide dissemination of data not previously available to the public. This lack of adequate distribution of vital information is considered one of the causes for governmental and semipublic attacks on the industry in the forms of killing taxes, investigations, court actions, etc. The attitude expressed in the new program is that an enlightened public will be a fair public.

Frank R. Clark discussed technical and practical developments in methods for discovering and producing oil before a press conference, referring to soil analysis, directional drilling and other similar developments with which general news correspondents in attendance were not familiar.

Dr. Gustav Egloff supplied the same type of information regarding the refining branch of the industry. He said it would be possible to supply the entire United States rubber requirements from synthetic products derived from butane. He touched on other uses of cracked and natural gases and the part catalytic treatment of hydrocarbons is playing in opening new fields for consumption of petroleum. The petroleum industry's big need, Dr. Egloff said, was to discover new and greater uses for its products. Ability to speed up the fruition process through use of butylene has vast potentialities and is even now being used extensively.

THE PRESIDENT'S ADDRESS

By Axtell J. Byles
President, American Petroleum Institute

Effects spring from causes. The economic effects upon the petroleum industry during this year spring, in no small part, from last year's causes.

The industry entered 1937 full steam ahead. The green light was up and the track clear as far ahead as one could see. Production of crude oil was approximately 3,200,000 bbls. daily, slightly more than 300,000 bbls. per day higher than at the beginning of 1936. Stocks of petroleum were approaching the lowest level since 1922 and demand for gasoline and other products was increasing by leaps and bounds. At the end of the first quarter of 1937 the Federal Reserve Board index of business activity had reached 118, the highest point since October, 1929, with the single exception of December, 1936. The business activity index continued at this figure through April and May, 1937. In June the index gave the first indication of the business decline which was to follow. Gasoline demand slowed down during the second quarter, the increase being only 9 per cent as compared with the first quarter's increase of 14 per cent. Crude oil production continued to establish new highs, reaching its all-time peak during the week of August 28, 1937, with a daily average of 3,750,000 bbls., bringing inventories to 311,000,000 bbls. on August 31, an increase of 23,000,000 bbls. since the first of the year, 100,000 bbls. per day having been added to storage during that eight-month period. There was a slight upturn in business in August, but in September the downward trend was resumed and continued throughout the balance of the year, with the business activity index dropping to 84 per cent in December.

Gasoline Demand

Gasoline demand in the third quarter of 1937 showed an increase of less than 8 per cent compared with approximately 9 per cent in the second quarter and 14 per cent in the first quarter. During the fourth quarter of 1937 gasoline demand showed an increase of but 3 per cent, with domestic demand registering a decline of almost half of 1 per cent during the month of December. Production of crude oil continued at high rates, however, and remained well over 3,400,000 bbls. per day as late as April of this year. Gasoline demand slowed down as a result of the declining rate of business activity and resultant lower purchasing power, but gasoline production did not slow down until March, 1938, at the end of which month inventories reached 92,000,000 bbls., which was more than 10,000,000 bbls. higher than at any previous time. The business recession continued until its low was established in May of this year at 76 per cent of normal.

Late in the summer and early in the fall of 1937 some of those engaged in the industry publicly began to point to uneconomic developments in the situation. The Texas Railroad Commission itself, aware of this, in November, 1937, inaugurated its first Sunday shutdown in East Texas. Despite this, the level of crude oil production came into 1938, for the nation as a whole, excessively high and gasoline production in relation to demand and economic inventory requirements did not taper off to any appreciable extent until the end of the first quarter of this year. The industry, therefore, entered the high consuming season of 1938 heavily overstocked with petroleum, gasoline, residual fuel oils and lubricants—the business recession having had a very pronounced effect on the consumption of the two latter products. Stocks of residual fuel reached a level about 25,000,000 bbls. higher at the end of the first quarter of this year than on the corresponding date in 1937.

Thus it will be seen that on April 1 of this year there was an inventory problem of major proportions, both as to crude oil and two of its principal products. The seriousness of the situation was augmented by new crude oil supplies, which will be shortly referred to. The economic pressures toward liquidation of both crude oil and products were probably not retarded by recollection of the conditions experienced in 1932 and 1933. It should also be obvious by now that the Madison experience was not constructive from any point of view. During the first half of this year net income of 24 units in the industry showed a decline of 40 per cent. Probably few, if any, refinery operations were showing a profit and many were showing heavy out-of-pocket losses.

Effect of Illinois

The new Illinois field developed into major proportions and its location between large refinery markets and their previous suppliers of crude oil, with consequent lower transportation costs to those markets, and the lack of any authority within the state to prorate production in accordance with recognized good engineering practices, aggravated the situation. Previous suppliers of this market were forced further to curtail, in order to meet the new conditions imposed. Underparity crude oil from this field, also from Kansas, Oklahoma, Louisiana and Arkansas, and finally from scattered points in Texas, together with the pressure of burdensome motor fuel inventories, contributed to the downward trend of gasoline, as well as crude prices. In other words, a process of erosion had set in which was due to several contributing causes. It finally resulted in a general reduction of crude oil prices, notwithstanding the fact that inventories thereof had, by that time, been reduced to levels which, uncomplicated by the factors heretofore referred to, would not have been burdensome.

Having referred to the development of the past 20 or more months, I now ask the question—What are economic inventories of crude oil? There seems to be considerable uncertainty and difference of opinion. As a general rule one would say that, in periods of abundance of available flush production, such as have existed for many years, the nearer aboveground supplies approach minimum economic working requirements, the better.

Under present circumstances, with crude oil inventories approaching 275,000,000 bbls., I ask another question—Have not crude stocks attained a relationship to economic levels which will in all probability make unnecessary and unwise further liquidation

There is but one greater need for this industry than a campaign of sound, accurate and honest public relations, which would result in better public understanding. That greater need is for such a campaign in what we might term domestic relations for the education of those engaged in the industry itself.—PRESIDENT BYLES

during the winter months and thus give relief to the producer in meeting current requirements of crude oil?

Any economist will admit that the nearer an even production rate is attained throughout the year the better. This not only is economically sound but it is true from the standpoint of conservation and from the standpoint of every one engaged in the industry whether he be wage earner, producer, transporter, refiner, or marketer, and for the consumer himself. Violent fluctuations in any industry are not in the interests of anyone.

Economic requirements of finished and unfinished gasoline on March 31 next, for the industry as a whole, in my opinion, probably will not exceed 80,000,000 bbls. That amount would leave room for seasonal build-up with which to augment the current supply during the 1939 high consuming months. These inventories are estimated to have been something less than 68,000,000 bbls. on November 1 of this year, which is approximately the same as a year ago. Your guess is probably as good as mine, but based upon the probable demand which one may expect for gasoline during the winter season, it is my belief that runs to stills of not more than 3,100,000 bbls. per day, on an average over the period, will probably result in only slightly higher inventories than minimum economic requirements.

Economic Inventories

With crude oil and gasoline inventories now at fairly economic levels and the distillate inventories sound, the only really burdensome inventory conditions remaining are those of residual fuel and lubricating oils. The pick-up in general business, if it continues as is hoped, will bring relief to these situations. In other words, the industry, while passing through the uncertainties and unpleasantness of the past summer, nevertheless did, to a large extent, liquidate the excesses of the previous year, and should be able to look forward to an improved position in 1939. However, this hope will not be realized, or this service rendered, if March 31 next finds the industry burdened, as it was last March, with uneconomic inventories.

Some states and some pools and some operators have contributed more to the industry's progress than have others. This raises the pertinent question as to what may properly be done to improve the long-term outlook in this business and brings us to a consideration of the basic subject of conservation and the role which proration plays in offsetting the industry's old man of the sea—the rule of capture. Conservation means the production of the maximum amount of crude oil from a pool at the least possible cost. Conservation means the prevention of waste, whether above or below ground—it does not mean fixed prices or the fixing of prices. Nor can conservation be justified as a price factor, but price itself is an unavoidable factor in proration. Were it not for the vast reserves contained in the pools of settled production, as typified by the stripper well areas, conservation might begin and end in the simple process of allowing flush pools to produce at a rate which would permit recovery of the maximum yield at the lowest cost. If this procedure resulted in overproducing the market demand, as unrestrained production in the past has often done and undoubtedly could do in the future, price punishment inevitably would slow it down. But the problem of conservation is not as simple as that, and thus the market demand clauses in the conservation laws of a number of states assume a vital importance in preventing floods of unrequired production and resultant decline in prices which would prove ruinous to thousands of operators. From the standpoint of conservation itself, such prices, if long continued, would either destroy the reserves in fields which could not be produced under such conditions, or would make the cost of ultimate recovery from such fields so excessive as to be seriously burdensome to the ultimate consumer.

It is recognized that proration cannot serve as a vehicle of conservation or, in fact, indefinitely endure, unless it is administered equitably, not only between wells in a pool, but between pools within states and also pools competing in the same trade channels regardless of state lines. It is also becoming generally recognized that proration reaches economic limits in cases where overdrilling reduces well allowables to the point where adequate return is not available for the capital and risk involved. Prevention of this requires proper drilling patterns or well spacing. It is generally conceded that only by the intervention of the conservation authorities of the states, implemented with essential legislation under the states' police power, can this be brought about.

A.P.I. — Technical Papers presented at the Annual meeting in Chicago, Nov. 14-18, begin on page 100 of this issue

It is my personal belief that conservation, through proration based upon proper well spacing and production practices, will not and should not bring fixed or pegged price crude oil. That from time to time the power of a flexible price will and should take charge of the situation, encouraging or discouraging development and production, thus tending to keep them within economic requirements. This industry has no right to special price consideration other than that essential to prevent physical waste. It seems to me, however, that under proper conservation practices, much narrower swings in the price trend are likely to occur than were experienced prior to production under proration. In other words, let me say, merely by way of illustration, that something like a 5- or 10-cent increase or decrease in the price of a barrel of crude oil rather than violent fluctuations upward or downward should be logical and wholesome development of the proration system. Conservation through proration must presuppose a fair and reasonable price to the producer of petroleum, not only to encourage him to find and develop pools but to conserve and make available the vast reserves within pools of settled production.

This brings us to a consideration of how conservation by state authority and interstate cooperation, which has made such commendable progress during the last few years, may widen and improve its field of usefulness. First, I believe that Government and industry are agreed that the Connally Act, preventing interstate shipment of oil illegally produced, should be renewed and made permanent. Second, that state and federal approval of the continuance of the Interstate Oil Compact should be given. Third, that all states which are producing petroleum should join the compact and those lacking conservation laws should enact them, and in such form as to gain the benefit of modern engineering and scientific knowledge, which makes possible proper well patterns and proper conservation of reservoir energy.

In the long run a state, like an individual, does not profit by trying to live unto itself alone but best profits and best serves by cooperation with other states in matters of wide public concern. The compact authority has not and, in my opinion, never should have powers of compulsion. Its power and usefulness rest upon the fact that it provides a forum for exchange of information, discussion and recommendation, leaving to its member states complete independence of decision on the action to be taken.

The record of the Interstate Oil Compact Commission during the three years of its existence has been a commendable one. No member of the commission would, I am sure, disagree with the statement that there remains much more to be accomplished for state and national welfare than the commission within the short period of its existence has as yet been able to accomplish. The commission will be seriously handicapped, however, unless it has the full and complete cooperation of all producing states, particularly Illinois, Louisiana, Arkansas, Michigan and California. The State of Illinois is already a member of the compact but has not as yet adopted a conservation law. If, as we are convinced, oil pools developed and produced in accordance with now known sound engineering practices, will yield a volume of petroleum greatly in excess of the amount which would be recovered under the old anti-conservation methods, enlightened selfishness would indicate the adoption of sound conservation laws by states which at present have no such laws, and improvements, by amendment, to those laws in states which are not abreast of current engineering knowledge.

Public Protected

At this point the question may properly be asked as to what effect the perfection of conservation control by the petroleum producing states will have upon the nonproducing states, or, to broaden the question, what effect upon the consumer who, by the way, many times outnumbers the producer even in the petroleum states themselves. It is not reasonable to believe that state conservation authorities, even were they so minded, could not politically survive if they abused their powers to the detriment of the consumers within their own states. This insures equal protection to the consumers outside the borders of those states. Finally, the federal Government, through its power to control imports, has power to prevent price abuses of conservation practices.

In the latter connection it may not be amiss to refer to the confiscation of American and British-owned oil properties by the Mexican Government, and draw attention to the appalling consequences to this nation should this practice be permitted to spread to the vast American holdings in South America and elsewhere. Mexican oil is now coming into the United States in seemingly increasing quantities. This oil is said to be coming from government-owned wells. It is difficult, to say the least, to differentiate between the sale of confiscated or stolen oil and oil the sale of which is made possible through ability to replace it with confiscated or stolen oil. It is well known that government-owned wells in Mexico are not nearly sufficient to supply the raw material from which Mexico's home consumption of refined products is made. This makes it doubly difficult to understand how the oil now being imported into the United States can be of clean moral title, to say the least. Vast petroleum reserves in Mexico and in Central and South America, owned by citizens of the United States, are at our gates, cheaply and immediately available to the American consumer if, as and when they are needed in times of peace, and to our Government in time of war—unless they are confiscated.

With the renewal of the Interstate Oil Compact up for consideration in state legislatures and in the next Congress, the industry is properly giving much thought as to what, if any, amendments

(Continued on Page 94)

Missouri Wildcat Seeking Deep Pay in Shallow Oil District

By DAL DALRYMPLE

While northern Missouri is in the oil spotlight right now with widespread leasing under way in nearly a score of counties within or on the rim of the Forest City Basin, western Missouri is not without interest for the petroleum industry. As many independent operators and some major companies study the geology of the northern counties and assemble big blocks of acreage thereabouts, other operators are going quietly about the business of obtaining leases, drilling shallow producing wells and seeking deep production in some of the western counties.

This western Missouri activity largely is centered in the Nevada district of Vernon County, in Bates and Cass counties to the south of Kansas City, and in Henry and St. Clair counties. Vernon, Bates, and Cass are in the westernmost tier of counties bordering Kansas, with Henry and St. Clair in the second tier of counties east of Kansas.

An Ordovician Test

The Vernco Oil Co. No. 1 Wilmot in the C SE Section 36-37n-33w, about 6 miles north and 7 miles west of Nevada and nearly 6 miles from the Kansas line, is a projected 3,000-foot test, unless oil is found in Devonian, Silurian or Ordovician sands at a lesser depth. The location was based on geology by W. R. Julian, Shreveport, La. It was expected that sands in the deeper horizons would be found at from 1,200 to 2,500 feet. Rotary equipment is being used, the 96-foot derrick thought to be Missouri's first rotary. At the week-end, operators had completed a fishing job and were drilling and coring ahead in sandy shale after passing out of Mississippi lime at 1,017 feet.

The Vernco company entered this area about two years ago, leased between 25,000 and 30,000 acres in Vernon County and began drilling shallow wells, testing the upper horizons and studying the geology of the district, preparatory to starting the rotary test. Two other deep tests on the Vernco block are planned, regardless of the outcome of No. 1 Wilmot.

First Deep Test

The first deep test drilled in the Nevada district was the Nevada Oil & Gas Co. No. 1 Henshaw, Section 31-37-32w, 1 mile east of No. 1 Wilmot. Locally financed, it was drilled about 20 years ago. After drilling to 1,870 feet, it was given too heavy a shot, water intruded and it was abandoned. Several showings of oil were logged.

While the proving of the Nevada district for deep production awaits the result of the Wilmot or future deep tests, shallow productive possibilities of the area have been known for several years.

The Vernco company completed a 5-bbl. well in the shallow pool southeast of Richards and northwest of Nevada the past week, production being found at 250 feet, in Burgess sand. It had 31 feet of saturated sand. The company also recently completed a Bartlesville sand well 1 mile west of Richards, this test producing 3 bbls. of oil and 250,000 feet of gas daily at a total depth of 170 feet.

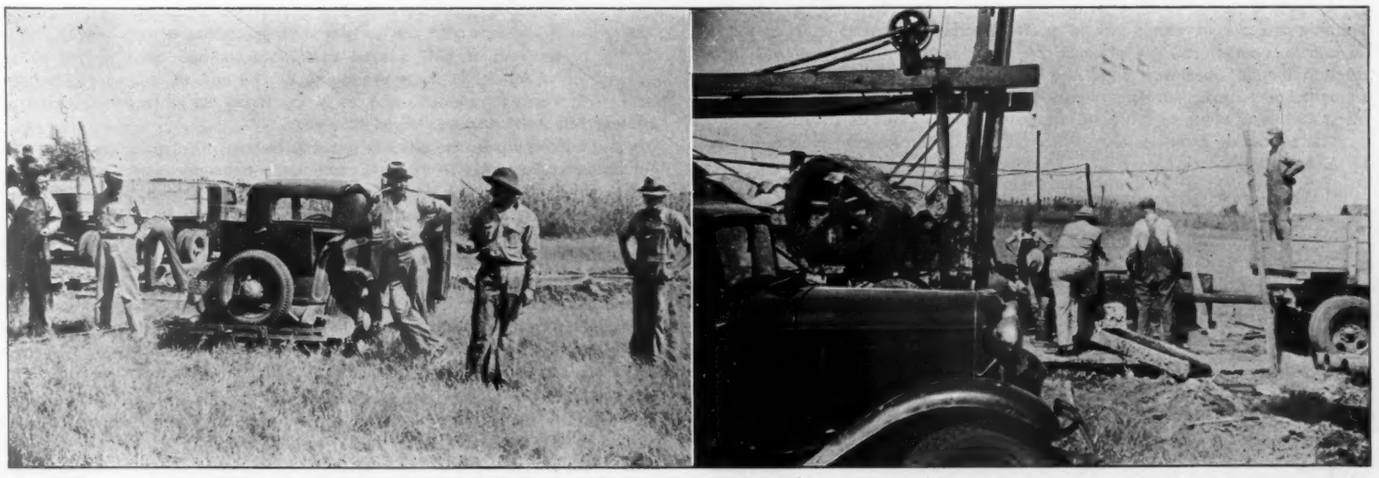
Arch Miller and Jack Davis, operators from Hutchinson, Kans., who became active in Vernon County some months ago, recently completed the banner shallow producer of the area. This well, located 1 mile east of the village of Richards, found Bartlesville sand productive at 109 feet, was drilled to 140 feet, bailed 15 bbls. of oil in four hours and was completed for initial production of 30 bbls. in 24 hours. Production declined after four days but at last report it was yielding about 10 bbls. of oil daily. Within the last three months these operators have completed three other Bartlesville sand wells, each averaging 5 bbls. of oil daily.

The first production in Vernon County was found in 1901, when the Stotesbury pool was opened in Township 37n-33w, oil coming from Bartlesville sand at 250 feet. More sensational discoveries in Kansas and Oklahoma prevented intensive development of the area, and it was not until 1920 that the next strike was recorded in the Nevada district. In that year the Richards pool in Township 36n-33w was opened, with oil being found in Bartlesville sand at 225 feet. Then some 200 shallow oil wells and 20 or more gas wells were drilled and two small refineries were constructed to utilize the production. After a time that play waned, the refineries were dismantled and it was not until 1928 that the next strike was recorded, this resulting in opening of the Swarts-Garland pool in Township 34-33w, producing from Bartlesville sand at 200 feet. There was little or no development during the next 10 years, activity not being resumed until a few months ago when Vernco and Miller & Davis became active.

Gas in Bates County

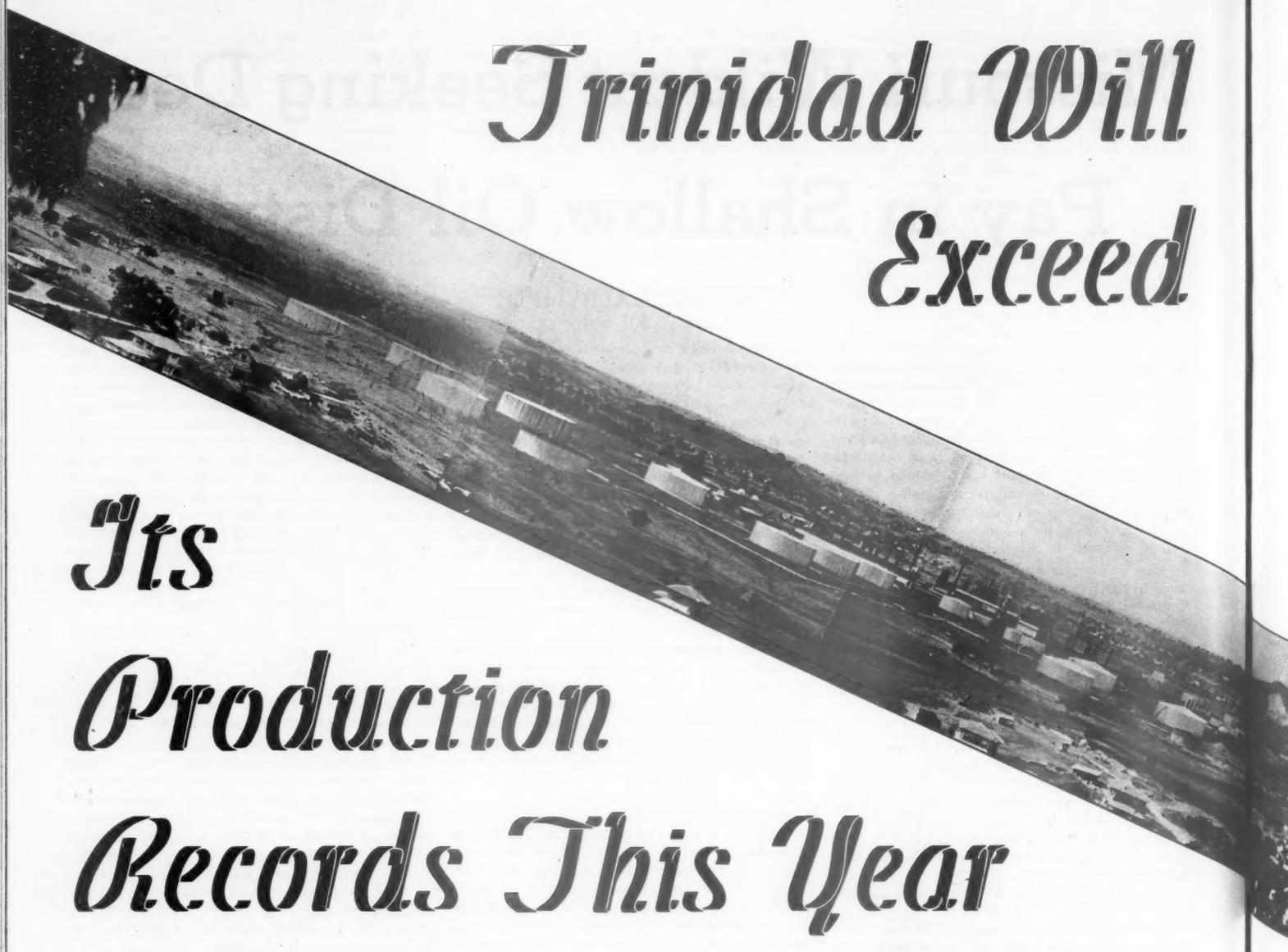
In the meantime, however, gas had been found to the north in Bates County, the Ackerman pool being opened near Hume in Township 38n-33w in 1931. The Lang gas pool near Amsterdam in Township 41-33w, Bates County, also was opened that year. Production in these two pools was from Bartlesville sand at 375 and 350 feet.

The initial flow of some of the oil wells drilled in shallow pools of Vernon, Bates, and other western Missouri counties has been reported as high as 50 to 70 bbls. daily, but 5 to 10 bbls. is much more general, according to a report of the Missouri Bureau of Geology and Mines. After being shot and placed on the pump the wells settle to about 2 bbls. daily and maintain that output over a long period. This is probably to be explained by the fact that the oil is of low gravity, mostly 20 to 25 degrees Baume, and consequently seeps rather slowly from the sand into the wells.



Action in the Missouri oil field: Left, preparing to drill a shallow well in the Nevada district, with Arch Miller, operator, leaning against the car. Right, pouring sand on top of nitro to hold explosion down in a shallow Vernon County well

Trinidad Will Exceed Its Production Records This Year



PORT-OF-SPAIN, Trinidad, Nov. 14.—The island of Trinidad is certain to have the highest output in its history this year. With production for September the largest of any month, and the total for the first three quarters 12,974,256 bbls., it is estimated that production for the year will be approximately 17,750,000 bbls.

Refining output will also establish new peaks, with drilling operations about the same as last year.

An article in the October 20 issue of The Oil and Gas Journal, page 26. summarized the developments in production and refining as they apply to market operations. The present discussion will be concerned with production trends, operating data, and other factors which have to do with present and future operations in this island, which is the only part of the West Indies to show commercial oil production up to this time.

The following table gives the latest crude-oil production in the colony by companies:

CRUDE OIL PRODUCTION FOR COLONY FOR SEPTEMBER, 1938

	(Bbls.)
Antilles Petroleum Co. (Trinidad), Ltd.	28,756
Apex (Trinidad) Oilfields, Ltd.	321,874
The Coldan Co., Ltd.	180
Kern Trinidad Oilfields, Ltd.	104,163
New Dome Oilfields, Ltd.	5,450
Petroleum Options (1925), Ltd.	1,447
Premier (Trinidad) Oilfields, Ltd.	3,762
Siparia Trinidad Oilfields, Ltd.	19,920
Trinidad Central Oilfields, Ltd.	104,804
Trinidad Consolidated Oilfields, Ltd.	64,958
Trinidad Leaseholds, Ltd.	372,153
Trinidad Oil Fields Operating Co., Ltd.	17,348
Trinidad Oil Lands, Ltd.	899
Trinidad Petroleum Development Co., Ltd.	243,742
United British Oilfields of Trinidad, Ltd.	221,415
Zenith Trinidad Oilfields, Ltd.	4,022
Total	1,514,893
Daily average	50,496

In several cases this is the largest production ever recorded by the companies, several of which have been operating here for many years.

By C. O. WILLSON

While a production of 1,000 bbls. was reported in Trinidad as far back as 1867, it was not until 1902 that a systematic exploratory development was started, and it was not until 1912 that an output in excess of 100,000 bbls. for 12 months materialized. The growth of the production branch of the industry is shown in the accompanying charts.

Up to the end of 1937 a total of 2,705 tests had been drilled in the colony, of which 1,238 were producing at the end of the year, 726 were idle, 677 were abandoned, and 64 were listed as unfinished. Approximately 180 wells will be drilled this year.

The ownership in Trinidad is unusual in that oil operations are carried on under concessions from the Crown and on properties leased from private owners. Three divisions are recognized. The Crown rights are those derived directly from the government which owns the mineral rights. The term "alienated rights" is applied to those cases in which the fee ownership rests with private parties but the mineral rights are controlled by the government. In the case of private rights both the fee and mineral rights are now owned privately. About 45 per cent of the production is obtained from Crown properties, 18 per cent from alienated rights and the remainder from private rights. It is estimated that more than 500,000 acres are under lease now, or nearly 50 per cent of the entire island.

Consideration is now being given to marine concessions. It is reasonably certain oil will be found in waters adjoining producing properties and requests for concessions have been made. The government of the colony supported by the home government is said to favor an arrangement whereby those entitled to concessions would pool their interests and proceed under a unit ownership plan. Some of the private owners are not receptive to this plan and no action has been taken in regard to

the marine properties which later may add materially to the known reserves of the island.

The government collects royalties, rents and fees from oil properties and it is estimated the revenue this year will total approximately $1,000,000. Oil exports in value represent 60 per cent of the yearly total from the island. The royalty is based on a graduated scale, the rate increasing with advances in the value of the crude. The present rate is 8 cents per barrel based on a crude valuation of approximately $1.50 per barrel. In this connection prices are determined by the going market for gasoline and fuel oil at the Gulf Coast.

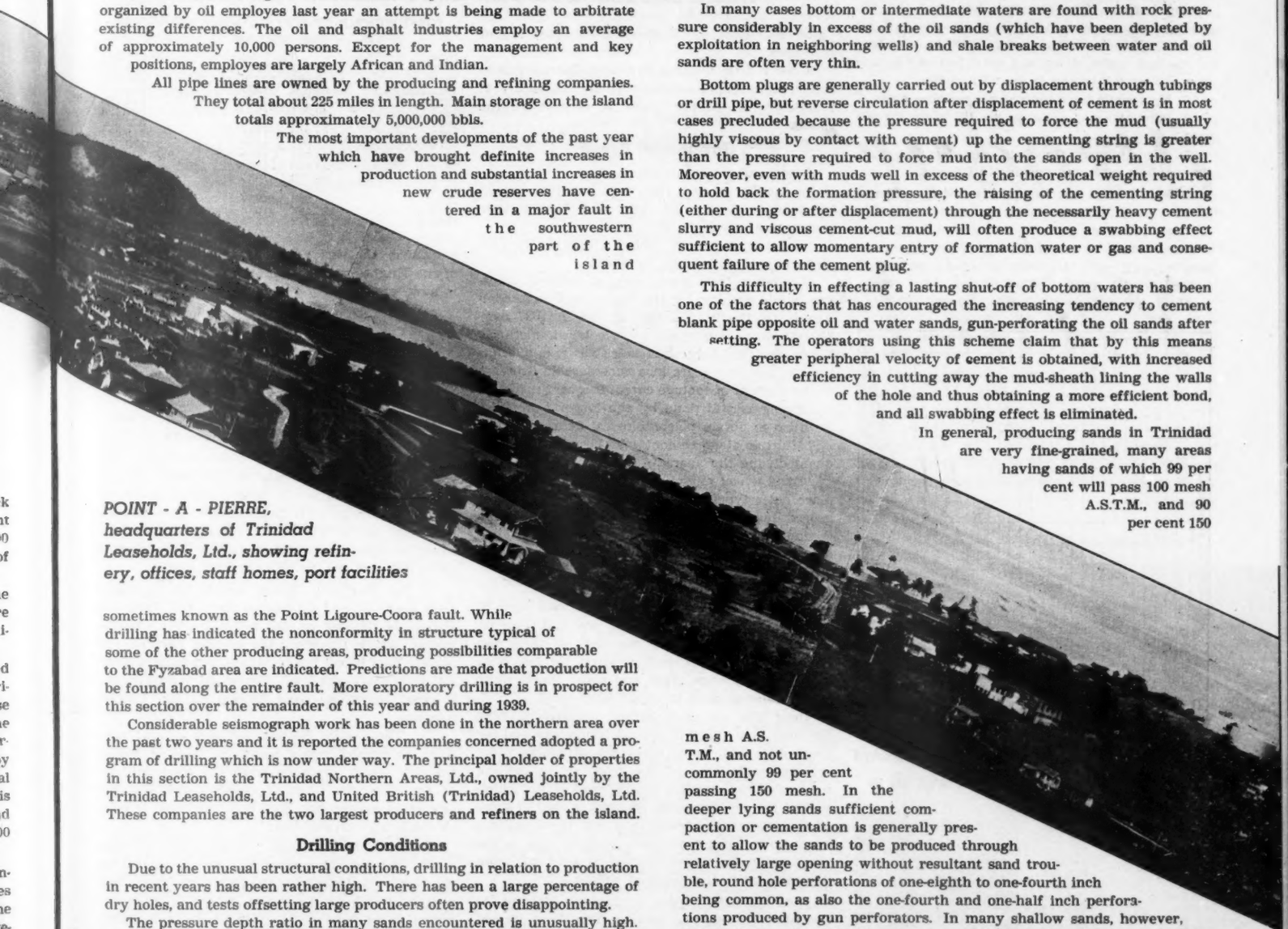
This reflects the fact that about 95 per cent of Trinidad's crude oil and refinery output is exported on a market competitive with market conditions at the American Gulf Coast, which is also a large exporter of petroleum products.

Working under the inspector of mines, the colonial government maintains supervision over petroleum operations. A field office is maintained at San Fernando. Several pamphlets have been issued explaining these regulations and these are available from the government printer here. In many respects the regulations are patterned after those of California. With less than 20 active operators little trouble has been experienced in enforcing all regulations and many details of operation are carried out through agreements by the operators themselves. While operating methods are patterned after those in the United States, unusual conditions encountered both above and below the surface are reflected in operating practices.

Labor conditions have been quiet since the serious disturbance of the summer of 1937. Through mutual consent of operators and the trade union organized by oil employes last year an attempt is being made to arbitrate existing differences. The oil and asphalt industries employ an average of approximately 10,000 persons. Except for the management and key positions, employes are largely African and Indian.

All pipe lines are owned by the producing and refining companies. They total about 225 miles in length. Main storage on the island totals approximately 5,000,000 bbls.

The most important developments of the past year which have brought definite increases in production and substantial increases in new crude reserves have centered in a major fault in the southwestern part of the island sometimes known as the Point Ligoure-Coora fault. While drilling has indicated the nonconformity in structure typical of some of the other producing areas, producing possibilities comparable to the Fyzabad area are indicated. Predictions are made that production will be found along the entire fault. More exploratory drilling is in prospect for this section over the remainder of this year and during 1939.



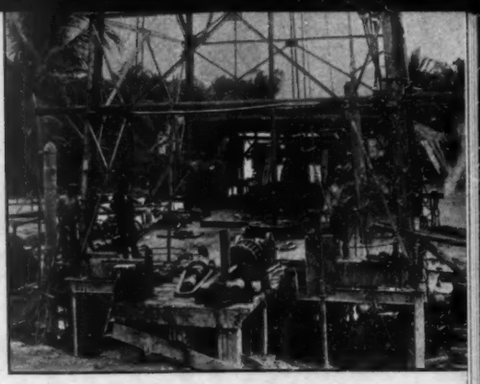
POINT - A - PIERRE, headquarters of Trinidad Leaseholds, Ltd., showing refinery, offices, staff homes, port facilities

Considerable seismograph work has been done in the northern area over the past two years and it is reported the companies concerned adopted a program of drilling which is now under way. The principal holder of properties in this section is the Trinidad Northern Areas, Ltd., owned jointly by the Trinidad Leaseholds, Ltd., and United British (Trinidad) Leaseholds, Ltd. These companies are the two largest producers and refiners on the island.

Drilling Conditions

Due to the unusual structural conditions, drilling in relation to production in recent years has been rather high. There has been a large percentage of dry holes, and tests offsetting large producers often prove disappointing.

The pressure depth ratio in many sands encountered is unusually high. Formation pressures have been recorded of 150 per cent the pressure of water column at the depth recorded, and mud weights equivalent to considerably more than this 150 per cent are often needed to ensure protection against blowouts should gas-cutting occur when drill-pipe is out of the hole (e.g., running electrical logging instruments), and to overcome the reduction in pressure caused by the swabbing effect of pulling drill pipe.



A wildcat in Trinidad

This results in the widespread use of heavy muds, which in nearly all cases are made by the addition of barytes to normal shale mud. Mud weights of 120 pounds per cubic foot are common, and in exceptional cases rise as high as 130-135 pounds per cubic foot. Due to the high costs of maintaining heavy barytes, several operators maintain separate mud plants for each area of activity, at which plants the necessary muds are mixed and pumped to the wells as required, used-up muds being pumped back to the mud plants, through a separate return line, for reconditioning and recovery of barytes when further chemical conditioning at the well is no longer possible.

Apart from adding very considerably to the cost of drilling, the use of heavy muds, which even with the best treatment rapidly becomes of a much more viscous nature than normal shale muds, makes it difficult to maintain adequate circulation in deep holes with the smaller sizes of drill pipe.

Normal cementation of casings is not particularly affected by the use of heavy muds, provided adequate clearance is available, but the placing of bottom plugs becomes a problem that has not yet been satisfactorily solved.

In many cases bottom or intermediate waters are found with rock pressure considerably in excess of the oil sands (which have been depleted by exploitation in neighboring wells) and shale breaks between water and oil sands are often very thin.

Bottom plugs are generally carried out by displacement through tubings or drill pipe, but reverse circulation after displacement of cement is in most cases precluded because the pressure required to force the mud (usually highly viscous by contact with cement) up the cementing string is greater than the pressure required to force mud into the sands open in the well. Moreover, even with muds well in excess of the theoretical weight required to hold back the formation pressure, the raising of the cementing string (either during or after displacement) through the necessarily heavy cement slurry and viscous cement-cut mud, will often produce a swabbing effect sufficient to allow momentary entry of formation water or gas and consequent failure of the cement plug.

This difficulty in effecting a lasting shut-off of bottom waters has been one of the factors that has encouraged the increasing tendency to cement blank pipe opposite oil and water sands, gun-perforating the oil sands after setting. The operators using this scheme claim that by this means greater peripheral velocity of cement is obtained, with increased efficiency in cutting away the mud-sheath lining the walls of the hole and thus obtaining a more efficient bond, and all swabbing effect is eliminated.

In general, producing sands in Trinidad are very fine-grained, many areas having sands of which 99 per cent will pass 100 mesh A.S.T.M., and 90 per cent 150 mesh A.S.T.M., and not uncommonly 99 per cent passing 150 mesh. In the deeper lying sands sufficient compaction or cementation is generally present to allow the sands to be produced through relatively large opening without resultant sand trouble, round hole perforations of one-eighth to one-fourth inch being common, as also the one-fourth and one-half inch perforations produced by gun perforators. In many shallow sands, however, the sands are of a much looser nature, and although not necessarily finer grained than the deeper sands, present considerable difficulty with respect to sand control. *(Continued on Next Page)*

1. Producing depths vary from a few hundred feet to two wells over 9,000 feet. Of the 1,170 wells reported operating at the end of 1937, a majority were under 3,000 feet. Of the remainder 199 were over 4,000 feet, 59 over 5,000 feet, 26 over 6,000 feet, 12 over 7,000 feet, 3 over 8,000 feet and 2 over 9,000 feet. So far this year there has been an average of 40 wells drilling.

2. Pressures up to 3,200 pounds casinghead are encountered.

3. The following table shows the division of operating wells at the close of 1937:

Flowing	357
Pumping	491
Bailing and swabbing	139
Air or gas lift	100
Plunger lift	68
Displacement pump	15
Total	1,170

So far this year about 175 wells have been drilled with a large percentage flowing at this time.

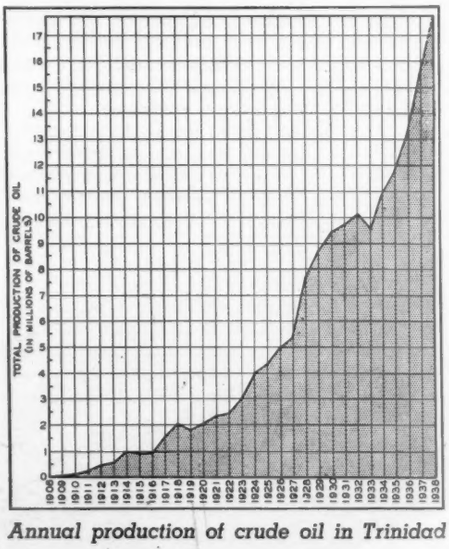
4. A typical casing program starts with either 16-, 13⅜-, 11-, or 8⅝-inch surface string set to a depth of from 200 to 800 feet. Sometimes a water string of 9-inch casing is used and the usual oil flow string of casing is 6⅝-inch diameter. The 6⅝-inch pipe is gun perforated opposite the producing horizon. One company has used the following program in some of its wells—400 to 1,000 feet of 13⅜-inch surface casing, 2,000 to 3,800 feet of 8⅝-inch water string and 4,000 feet of 6⅝-inch flow string. All casing is set with cement.

5. Most wells have individual pumping units.

6. Percentage of wells on gas lift about 10 per cent.

7. Prime movers. One field uses electric power. Gas engines replacing steam. No Diesels.

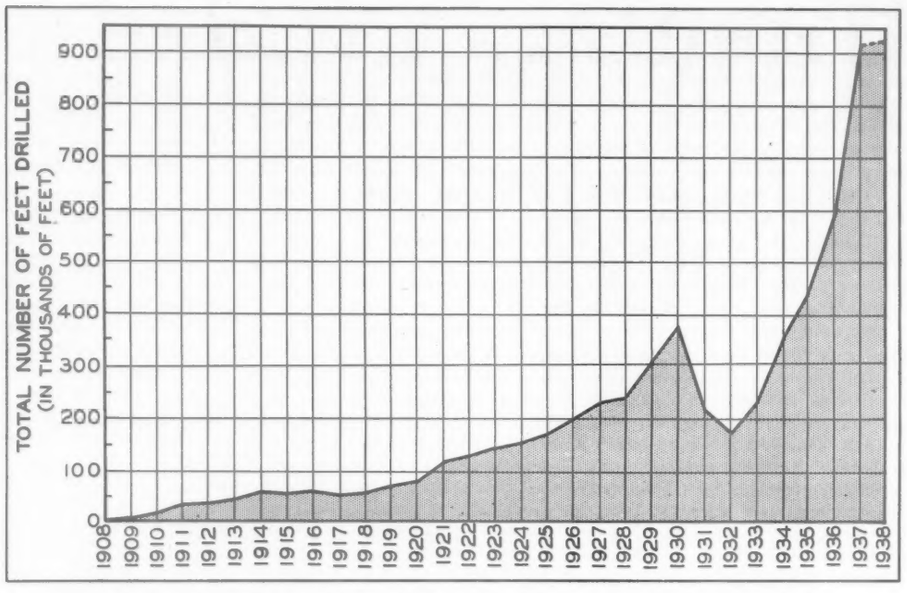
8. Sand only special problem in servicing pumps. Good highway system makes it possible to use portable pulling machines. Sand and crooked holes in a few fields which make it necessary to pull rods. Majority of operators install lighter derrick after drilling is completed. There is also an increasing number of well servicing units. Estimated 10 of these units operating at this time.



Annual production of crude oil in Trinidad

TOTAL ANNUAL PRODUCTION OF CRUDE OIL IN BARRELS

1908	37	1924	4,058,060
1909	47,295	1925	4,386,510
1910	105,078	1926	4,971,479
1911	221,292	1927	5,380,830
1912	485,905	1928	7,684,587
1913	585,182	1929	8,715,788
1914	993,216	1930	9,418,957
1915	904,719	1931	9,743,498
1916	927,875	1932	10,126,121
1917	1,602,302	1933	9,561,353
1918	2,081,920	1934	10,894,363
1919	1,841,036	1935	11,671,224
1920	2,083,110	1936	13,237,030
1921	2,334,159	1937	15,502,989
1922	2,444,670	1938	*17,750,000
1923	3,050,787	*Estimated	



Trend in the number of feet of hole drilled annually for oil in Trinidad

TOTAL NUMBER OF FEET DRILLED ANNUALLY IN THE COLONY

1908	0	1924	151,328
1909	5,362	1925	168,893
1910	8,090	1926	200,657
1911	38,912	1927	241,673
1912	39,720	1928	243,186
1913	40,201	1929	307,482
1914	58,429	1930	372,656
1915	54,860	1931	218,642
1916	58,901	1932	173,287
1917	50,784	1933	235,702
1918	54,496	1934	351,783
1919	66,510	1935	436,299
1920	78,676	1936	594,529
1921	118,845	1937	911,575
1922	136,463	1938	*915,000
1923	145,772	*Estimated.	

Government Report

A government report says:

"A number of new rigs were imported during the year, most of which were of a heavier type than was in use last year.

"The use of rotary tables with directly coupled engines noticeably increased.

"Deviation tests were taken at frequent intervals while drilling by the more important companies. Of the 911,575 feet drilled in 1937 over 850,000 were surveyed by electrical methods. While electrical logging of holes has resulted during the last few years in a considerable decrease in the amount of footage cored, frequent mechanical coring is still done by the larger companies in order to obtain paleontological data.

"Multiple stage cement jobs became more frequent during the year.

"Band wheel pumping powers continued to replace older types of central pumping power. One geared pumping power was put into operation during the year and a second was being installed at close of 1937."

Drilling

The 35 to 45 drilling rigs which have been in operation so far this year are practically all rotaries. Approximately 90 per cent of these use steam power. One Diesel powered rig has been used in the proven areas and three Diesel units are now being used in exploratory tests.

Drag bits are used almost exclusively, rock bits only being used in special formations and for short distances. Local clays are satisfactory for drilling muds. One of the most active drilling companies has installed central mud plants which service the drilling wells. Aquagel is used in some of the exploratory tests. In a few cases drilling muds up to 130 pounds are necessary due to the pressures encountered. Baroid is used to bring this mud up to the required weight.

None of the supply companies attempt to furnish a fishing tool service. The three largest oil companies maintain their own stocks of fishing tools.

Electrical logging is generally used. One company over the past year has made extensive use of the Hughes plunger lift. It is estimated that it is now installed on 68 wells.

Topography

Trinidad has an area of approximately 1,974 square miles. The average length and width of the island are 50 and 40 miles, respectively.

Considered in general, the island may be divided into five main physiographic provinces, two of which embrace smaller divisions.

1. The Northern Range, which embraces the entire mountainous region at the north end of the island, contains 418 square miles, much of which is covered with dense jungle. In this area are many of the most picturesque and naturally beautiful spots in the West Indies. The greatest elevations are not much over 3,000 feet.

2. The Northern Basin, which lies immediately south of, and contingent upon, the Northern Range, is flanked on the south by the Central Range, which traverses the central part of the island. This broad basin, which is nowhere over 100 feet above sea level, has at its western side a great inundated area known as the Caroni Swamp.

(*a*) The Caroni Swamp includes a low, partially inundated region along the Gulf of Paria, through which drainage from the western half of the Northern Basin is concentrated. Part of this great swamp has been reclaimed and is now valuable agricultural land.

3. The Central Range trends north of east across the central part of the island separating the Northern Basin from the Southern Basin. The average width of the range, which is often referred to as Montserrat Hills, is about 5 miles, and the average elevation is between 500 and 1,000 feet.

(Continued on Page 94)

Trends in Field of Taxation as Seen by A. P. I. C. Director

By BAIRD H. MARKHAM
Director, American Petroleum Industries Committee*

During the first five years of its existence the American Petroleum Industries Committee has observed certain well-defined trends in the fields of taxation and public finance. In so far as the petroleum industry and the consumers of its products are concerned, certain of these trends are toward a more just and equitable tax program, and, as such, they should be supported and encouraged. Others would result in tax oppression and unwarranted legislative restriction, and thereby justify concerted opposition.

In the immediate future there probably will be greater pressure for gasoline-tax increases in certain states, although such a condition is not anticipated generally. Contrary to the popular belief, the greatest number of increases was made not during the depression, but in the boom year, 1929, in which 22 states enacted such increases. The number of gasoline-tax increases and the total number of regular and special legislative sessions held in each year are shown in the following table:

	Legislative sessions	Gasoline-tax increases
1929	54	22
1930	19	3
1931	70	12
1932	29	3
1933	87	1
1934	47	2
1935	66	5
1936	54	0
1937	58	5

Although this table shows a gradual leveling off of the trend of gasoline-tax increases, it should not be interpreted as indicating that future demands for gasoline-tax increases soon will disappear. There is considerable agitation in some states for such increases to match federal highway aid, for additional highway construction, and to finance general governmental functions. Each business recession proportionately reduces the yield of the established revenue sources, thus prompting the resort to more stable revenue sources such as the motor-fuel tax.

There is growing sentiment in opposition to local gasoline taxes. In one state the legislature wholly has deprived the municipalities of all power to levy such taxes, and in the other two states in which such taxes are a serious problem many of them have been repealed. The current trend definitely is toward the removal of the present taxes and opposition to the further enactment of such levies.

There is an increasing demand for the erection of rigid constitutional and legal barriers against the diversion of the motorists' tax funds. Missouri, Minnesota, Colorado, and Kansas already possess such safeguards.

Proposed constitutional amendments have been approved by the electorate at the November 1938 elections in Alabama, California, New Hampshire, and Michigan.

In Indiana and Nevada the initial steps have been taken toward the adoption of such constitutional amendments, but further legislative action is required before these amendments can be submitted for the approval of the electorate.

Preliminary action preparatory to the framing of such a constitutional amendment also has been initiated in Iowa, North Carolina, and North Dakota.

Because the privilege of obtaining gasoline-tax exemptions and refunds so frequently is abused, 12 states have abolished it altogether. A recent poll of the gasoline-tax administrators showed 80 per cent in favor of the complete elimination of all exemptions and refunds. In those states in which it is considered inadvisable to tax all motor fuel irrespective of its use, the refund privilege rigidly has been restricted so as greatly to minimize the abuses.

Tax on Lubricants

The federal Government and two states now tax lubricating oil. Although there are sporadic proposals to tax this commodity, any future trend toward such a tax seriously can be questioned. In practice, such taxes have been such unsatisfactory revenue sources, and have developed so many administrative difficulties that they are given little serious consideration by the responsible tax administrators.

Although the sales tax generally is presumed to be a depression levy, 27 states still rely upon this revenue source. Of the five state sales taxes in effect at the beginning of 1933, three applied to gasoline; but of the 27 now in effect, 20 exempt motor fuel.

The chain-store-tax movement unquestionably was accelerated greatly by the depression. Almost all of the early laws were all-inclusive, but the great majority of the recent laws specifically exempt petroleum outlets. Of the 13 laws in effect at the beginning of 1933, six applied to petroleum outlets. There are now 23 such laws in effect, but only seven apply to petroleum outlets. The most recent development in this field was the introduction of a federal chain-store tax bill which specifically exempts petroleum outlets not engaged in the sale of tires.

There is a noticeable trend toward the more rigid licensing of business. Exceedingly keen competition fosters fair trade and kindred legislation which requires licensing for the purpose of regulation.

Many regulatory measures are sponsored by well-meaning individuals wholly intent upon remedying certain unsatisfactory conditions. Although some legislation of a regulatory type is not specifically intended to apply to the petroleum industry, as introduced it is so comprehensive in scope oftentimes that it would be most adverse in its effects. In this category should be classed bills regulating unfired pressure vessels such as air-pressure equipment, and the licensing and filing of reports by all individuals repairing weighing and measuring devices.

The increased demands for highway beautification, particularly by the women's garden clubs and other such groups, undoubtedly mean an increased volume of legislation regulating the size and the location of signs and billboards.

For the past two years there has been agitation for state trade-mark legislation. Such a measure passed both houses of the Nevada legislature in 1937, but it was vetoed by the governor. Similar measures have been introduced in 15 other states, but all of them have failed to become law.

A bill which completely would modify the present basis of trade-mark registration from the common-law concept to the Continental system is expected to be introduced in the Congress during 1939. There seems considerable sentiment for some substantial modification in the present federal law.

When the date for the registration of motor vehicles is deferred from January 1 to April 1 or thereabouts, experience clearly shows that a much larger number of cars is in operation during the first part of the year. At the beginning of 1933 only two states permitted a full three-months' postponement, but four other states permitted a more limited deferment.

At the end of 1937 laws permitting a postponement of the registration date for two months or more were in effect in 22 states. In addition, 15 other states allowed so-called "periods of grace" intended to accomplish the same general result, but the very limited period greatly minimizes the beneficial effects.

During the past two years the trend in truck legislation definitely has been away from unreasonable regulation. No port-of-entry laws have been enacted, and the outlook is more assuring. Reciprocity laws have made considerable headway. Intrastate highway regulations are being modified so as to conform to the federal motor-carrier act.

BAIRD H. MARKHAM

*Abstracted from report of committee to American Petroleum Institute at Chicago.

I. P. A. A. Committee of 36 Names Sub-Committees

FORT WORTH, Tex.—Thirty members of the Committee of 36 appointed at the annual meeting of the Independent Petroleum Association of America in Tulsa, met here November 11 to discuss subjects referred to this committee at that meeting. These included: Pipe line divorcement; complete disintegration of all integrated companies; temporary prohibition of all imports of petroleum and its products; recommended total shutdown in all oil-producing states having regulatory bodies; umpire to make allocations that are enforcable between oil-producing states. President Roosevelt's suggestion for regulation of refining under the interstate compact was added. States represented at the committee's meeting were Texas, Oklahoma, Louisiana, New Mexico, Kansas, West Virginia, Pennsylvania, Ohio, Montana, Michigan, Illinois, and California.

A subcommittee of seven was named to study a proposal that the Connally "Hot" Oil Act be strengthened to provide for federal allocation of oil production by states.

"The plan would give an absolute balance of supply and demand," President Charles F. Roeser said. "It would not interfere with the Texas Railroad Commission's authority or any state regulation, but would limit the amount of oil that each state could ship in interstate commerce."

The Bureau of Mines already issues monthly estimates of the market demand for each state's oil.

The subcommittee will at the same time consider a plan for appointment of an "umpire" to allocate state quotas voluntarily. The subcommittee is composed of J. C. Hunter, Abilene, chairman; Amos L. Beaty, New York; Jake L. Hamon, Dallas; K. S. Adams, Bartlesville; Arthur H. Seeligson, San Antonio; J. A. Aylward, Wichita, and R. H. Foster, Fort Worth.

The following subcommittee of 11 was named to study the proposal of pipe line divorcement and complete disintegration of all integrated companies: Frank Buttram, chairman, Oklahoma City; J. E. Farrell, Fort Worth; Stan S. Welch, Artesia, N. M.; Winston P. Henry, Houston; E. C. Morarity, Wichita, Kans.; E. B. Reeser, Tulsa; George A. Hill, Jr., Houston; Alf Landon, Topeka; C. A. Lester, Dallas; J. S. Bridwell, Wichita Falls, and Joe K. Mahoney, El Dorado, Ark.

The following subcommittee of seven was named to study the question submitted by Charles F. Roeser, president, of refinery regulation through the Interstate Oil Compact Commission and to cooperate with a similar committee of the Western Petroleum Refiners Association: W. G. Skelly, Tulsa, chairman; L. H. Prichard, Oklahoma City; S. A. Guiberson, Jr., Dallas; C. A. Smith, Jr., Saginaw, Mich.; E. B. Shawver, Wichita, and Al Buchanan, San Antonio.

All of the subcommittees were instructed to complete their work and be ready to report to the main committee in Fort Worth at 10 a.m. on December 10.

The committee reaffirmed the imports action of the association at its annual meeting in Tulsa requesting increases in the federal excise taxes; restriction of imports to a ratio of 4.5 per cent to consumptive demand and taxation of crude petroleum and its products used as supplies for vessels.

The committee decided not to recommend a total shutdown in all oil-producing states having oil regulatory bodies. It was the opinion of the committee that no authority existed for calling the shutdown and that such an action would be impracticable.

Stripper Owners to Consider Barnsdall Offer Again

The plan offered by Barnsdall Refining Corp., to run crude from Osage County, Oklahoma, leases and store it at Barnsdall or Skiatook, with a charge of 12 cents for gathering and 1 cent a month for storage until purchased, was rejected at a meeting of owners of stripper wells in Tulsa last Friday, but it was decided to adjourn until a more representative meeting could be held. The market for about 3,500 bbls. of Osage and Tulsa county stripper oil was lost last month when Barnsdall shut down its refinery at Barnsdall.

Colonel Thompson Wires Criticism of Refiners

AUSTIN, Tex.—Criticizing refiners, Chairman E. O. Thompson of the Railroad Commission warned there is a limit to production control efforts when some seek to profit unduly by the restraint upon the independent producer.

His criticism was telegraphed to George A. Hill, Jr., Houston, vice president of the American Petroleum Institute, at Chicago, and Charles F. Roeser, Fort Worth, president of the Independent Petroleum Association of America.

"The price of gasoline inevitably goes up when the price of crude goes up," Colonel Thompson said. "We have a right to expect them to be consistent and reduce the price when crude goes down."

An advocate of extending regulation of the industry to include refining, Colonel Thompson wired:

"Some refiners have not played a fair game. They ran to stills excessively and built up a leaning tower of gasoline stocks which were then used as a self-serving excuse to break crude prices. The wholesale price to retail stations was not reduced. The public took notice. State laws can be passed to prevent physical waste in excessive gasoline stocks.

"Better stay away from dangerous federal control. Look at the plight of the rails if you wish to see what federal control or regulation does to an industry.

"There is a limit on our efforts at production control when there seem to be those who forever seek reasons to profit unduly on the restraint of the independent producer. It is unfair to ask the state to hold down production while others cut the price. The independents of Texas mainly have procured passage of the oil laws of Texas. Our law expires next June. Independents hold in their hands the reenactment.

"I would recommend consideration of these points."

Negotiations Under Way for Canadian Refinery Site

THREE HILLS, Alberta.—Hydro Petroleum Oils, Ltd., operating a number of small refineries in the prairie provinces, is considering the purchase of the Palisade coal mine site here as a refinery location.

Loan of $9,000,000 Obtained by Pan American P. and T. Co.

NEW YORK.—Pan American Petroleum & Transport Co. announced on Tuesday a financing operation involving $9,000,000 with the funds obtained from Equitable Life Assurance Society and Chase National Bank.

Mortgage notes were issued by the corporation to the Equitable in the sum of $5,500,000 and to Chase bank for $3,500,000. The former bears interest at 3¾ cent and is repayable in installments. The Chase note also is a serial maturity with interest ranging from 1.75 per cent to 3.50 per cent.

Proceeds will be devoted to retirement of indebtedness to Standard Oil Co. (Indiana), parent company, to the Federal Shipbuilding & Drydock Co., and to existing bank debt.

Obituaries

H. J. THOMPSON, 55, Wichita Falls, Tex., died last week. He was connected with the Texas Co. engineering force.

JOSEPH E. WALSH, 51, oil operator, died at San Antonio, Tex., recently. He was the discoverer of the Sandia oil field in Jim Wells County, and also had operated in the Mexia, Refugio and Mirando fields.

Continental Gets Big Well in South Eunice Extension Area

Another large producer for the northeast extension area to the South Eunice pool of Lea County, New Mexico, was registered Tuesday when the Continental Oil Co. No. 2-B-1 Lockhart, Section 1-22-36, rated an official potential of 1,800 bbls. of oil daily, with 1,400,000 feet of gas. Potential was based on 75-bbl. hourly flow on two-hour test through open 2-inch tubing, landed at 3,792 feet.

Previous to taking potential, the well had flowed 117 bbls. an hour for two hours between drill pipe and casing after drilling pay from 3,740 feet to 3,810 feet, the total depth, in lime. The extension area is located 2½ miles northeast of the South Eunice pool.

Failure in extreme eastern Lea County was recorded at the Conoco No. 1-A-5 Howe, Section 5-21-38, which was ordered plugged and abandoned at 3,192 feet, in anhydrite. Schlumberger survey revealed the test running low structurally and operator elected to abandon without drilling to the lime section. Test is about 2 miles north of the J. W. Brown No. 1 C. W. Parcell permit, a small well in eastern Lea County.

New Producing Area in Pottawatomie County

A new producing area on the eastern edge of Pottawatomie County, Oklahoma, has been opened at Morgan, Flynn & Cobb and Summit Drilling Co. No. 1 School Land, NE NE SW Section 16-8-5, between the Maud pool and the Carr City area of western Seminole County. It flowed 883 bbls. of oil in eight hours, cutting 1 to 2 per cent water, and was shut in for connections. Production was from perforations in Hunton lime at 4,030-33 feet, after plugging back from total depth of 4,270 feet when water was found predominant in Wilcox sand.

Osage Lease Sale on December 6

An auction sale of leases in Osage County, Oklahoma, will be held on Tuesday, December 6, at 10 a.m. in the Osage Auditorium on the agency campus at Pawhuska, Okla. Seventy-nine tracts, all but one being quarter sections, will be offered.

THE MARKETS*

CRUDE OIL: *Little change observable. There was believed to be a slight increase in the quantity of crude being moved from Illinois fields at concessions from posted prices. Continued shrinkage of the nation's stocks is exerting a beneficial effect on general conditions, helped by last week's drop in production, which more than offset the preceding week's advance.*

REFINERY: *Gasoline prices firmer, under the influence of heavy movement, with marked diminution of surplus stocks. Substantial purchases of regular grade motor fuel by large refiners are reported, the material being regarded as a good investment at current low prices. Natural gasoline stronger, with prices up in Oklahoma. Furnace distillates somewhat soft as a result of mild weather. Heavy industrial oils improving gradually.*

TANK-WAGON AND POSTED DEALER: *Although scattered price wars persist, upward adjustments in retail prices are reported in some eastern areas.*

FINANCIAL: *The oils did not keep step with industrials in last week's rise, but they moved into a much better position than they occupied the week before. Average of 30 representative stocks for week ending November 12: High, 29.87; low, 28.40; close, 29.53. Week ending November 5: High, 28.93; low, 27.93; close, 28.55.*

**Detailed information in Market Section.*

The OIL AND GAS JOURNAL

PRODUCING REFINING NATURAL GASOLINE PIPE LINE

Published weekly by The Petroleum Publishing Company at Tulsa, Oklahoma

Stop on Red

Just how heedless the industry was to the accumulating signs of warning that began as long ago as June, 1937, is forcibly illustrated in the address of President Axtell J. Byles at the American Petroleum Institute meeting in Chicago. The red light was ignored.

The slowing of the rate of increase in gasoline demand indicated the danger of overproduction, particularly in the presence of excessive stocks of crude, motor fuel and fuel oils. But it was not until after the opening of the main consuming season last spring, when new fields shifted competition, aggravating the situation, that the danger was fully realized, and not enough was done to save the season.

All this, of course, may be considered water over the dam, but the effects and the lesson remain. Now is the time to take precautions against disaster in the coming year.

Gasoline stocks have been reduced to last year's level which was too high. Mr. Byles estimates that economic requirements on March 31, will not exceed 80,000,000 barrels and that runs to stills during the winter should be kept at not more than 3,100,000 barrels daily average.

Crude stocks are near requirements, permitting producers to meet current needs. Improvement in general business is expected to take care of surplus residual fuel and lubricant stocks.

This is a plain picture, but with limitations. It will not do to assume that the mistakes in judgment made last season can be repeated this season because of improved prospects. There is a very definite limit to the demand for petroleum products, easily ascertainable, to guide operations.

The industry can have prosperity if it operates close to demand. The experience of the past season shows what happens when it exceeds the speed limit.

Conservation in the production of crude is closely tied in with sane operation in the manufacturing division. Proration, as Mr. Byles pointed out, reaches economic limits where overdrilling reduces well allowables to the point where adequate return is not available for the capital and risk involved.

Prevention of this, he says, requires proper drilling patterns or well-spacing. The increasing study being given to this subject may lead to the necessary consideration by state regulatory bodies and legislatures.

Criticism of conservation too often overlooks the fact that it has been only partially applied. It has been limited to a few of the oil-producing states. It could be made much more effective by the application of engineering knowledge to assure equitable administration between pools and between wells in a pool.

Producing states now outside the compact or without conservation laws can be shown the necessity and value of proper conservation just as producers who were at first opposed to conservation were won to approve it.

Orderly production, of crude and of products, will yield the best results to the industry, to the producing states and to the individual. It is the one path to prosperity.

The reduction of the excessive stocks of crude and gasoline which so long overhung the industry was due to realization of this fact and the resulting cooperation in the effort to return to balance.

Continuance of that cooperation is necessary to maintain that equilibrium between supply and demand which is essential to the general welfare of everyone interested in the industry.

The more loyally that program is supported the more quickly will the industry move forward.

Programs and Meetings

Elaborate Exhibits Planned For Houston Oil Show

According to Ed Lenzner, general manager of the Oil-World Exposition, contracts for space already signed indicate the 1939 oil show in Houston will be considerably larger than that in 1937. Approximately the same number of exhibitors who displayed equipment have taken space at this early date although the exposition will not be held until April 24 to 29, inclusive. Increased space has been made available both inside and outside of the exposition buildings and added facilities have been provided by the Coliseum. The additional space and facilities make it possible to arrange the exhibits—inside and out—in one compact area with the least chance of visitors missing a single piece of equipment.

ED LENZNER

Most of the new exhibiting spaces will be provided by a large annex immediately adjacent to the Coliseum, the greater part on the same level as the main floor while additional space has been provided on the ground floor of both buildings. All the outdoor exhibits will be located directly around the exposition buildings.

Geological Society of America Semi-Centennial Meeting

Fifty years of progress in the science of geology will be celebrated by more than 1,000 geologists from every section of the United States at the semi-centennial meeting of the Geological Society of America, at the Waldorf-Astoria Hotel, New York, December 28 to 30, it is announced by Dr. Arthur L. Day, of Washington, D. C., president.

A special anniversary day program on Friday, December 30, will feature geology's contributions to the development of the nation's natural resources. Representatives of the major fields of geology, including mineralogy, economic geology, paleontology, seismology and petrology, will report advances already achieved and outline problems yet to be solved.

The Paleontological Society, Mineralogical Society of America, Seismological Society of America, and the Society of Economic Geologists, associated societies, will hold their annual meetings as a part of the three-day program and will participate in the exhibits, scientific sessions and annual dinner of the Geological Society. Luncheons are planned by the Mineralogical Society on Wednesday, December 28, and by the Society of Economic Geologists on Thursday, December 29.

More than 50 exhibits, dramatizing the work of geology in all its branches, are being arranged by Dr. E. H. Colbert of the American Museum of Natural History, chairman of the exhibits committee. Maps, models, delicate geological instruments, and mineralogical and paleontological items will be displayed by geologists from more than a score of educational and research institutions and by an equal number of city, state and federal agencies.

Tulsa Geological Society And A.I.M.E. Section

The Mid-Continent section of the American Institute of Mining and Metallurgical Engineers is sponsoring a joint meeting with the Tulsa Geological Society, to be held in the Tulsa Building, Tulsa, Monday evening, November 21, at 8 o'clock. A paper on "Core Analysis and Interpretation" by Howard C. Pyle and John E. Sherborne, both of Union Oil Co. of California, will be presented by Mr. Pyle. The meeting is open to all interested.

Oil Exhibits at World Fairs Sought for 1940 Exposition

CHICAGO, Nov. 16.—President W. G. Skelly, of the International Petroleum Exposition, announced at the American Petroleum Institute meeting that work is already progressing with plans to enlarge the scientific and technical displays in the new Hall of Science Building at the exposition to be held in Tulsa, May 18-25, 1940. The directors are working to secure for the Tulsa exposition the petroleum exhibits at the New York and San Francisco world fairs, General Manager William B. Way reported to Dr. Gustav Egloff, who was chairman of the scientific and technical committee in 1938 and will also serve in that capacity for the 1940 exposition. Mr. Way also addressed the Institution of Petroleum Technologists meeting.

Alberta Petroleum Association

CALGARY, Alberta.—At its annual general meeting the Alberta Petroleum Association elected the following officers: President, Herbert Greenfield; vice president, F. M. Graham; secretary-treasurer, E. W. Kolb; directors, Messrs. Greenfield and Graham with F. P. Byrne, R. A. Brown, Sr., William Kemp, G. E. Watt, P. Sanderson and Harry Thorne.

Transportation Association of America Selects New Directors

At the annual meeting of the Transportation Association of America in Chicago, November 10, the following were elected to fill three-year vacancies on the board of directors: Benjamin F. Affleck, Chicago; F. R. Bigelow, St. Paul, Minn.; L. R. Clausen, president, J. I. Case Co., Racine, Wis.; J. T. Fleishel, St. Louis, Mo.; Dr. Glenn Frank, Chicago; W. J. Hammond, vice president, Inland Steel Corp., Chicago; C. C. Hine, Los Angeles; R. C. Hobbs, St. Louis, Mo.; R. C. Ingersoll, Chicago; J. L. Keeshin, Chicago; Fred I. Kent, New York; J. L. Madden, New York; Howard C. Mull, vice president, Warren Tool Co., Warren, Ohio; G. H. Ostermann, Timken-Detroit Axle Co., Detroit; G. E. Scott, president, American Steel Foundries, Chicago; Paul Shoup, Los Angeles.

The directors reelected J. L. Madden as chairman of the executive committee; J. A. Gordon, president; Donald D. Conn, executive vice president; Sydney Anderson of Minneapolis, George R. Carr of Chicago, and Roscoe C. Hobbs of St. Louis as vice presidents; Perrin C. Miller of Chicago, treasurer; and E. C. Krogh, secretary.

The directors notified President Roosevelt's "committee of six," composed of three representatives each of rail management and labor, that all of the association's research material and its recommendations looking to a sound national transportation policy, were available to the committee.

West Central Texas Oil And Gas Association

Plans for the arrangement of program details at the annual convention of the West Central Texas Oil and Gas Association at Abilene, Tex., December 10 will be under direction of 60 volunteer Chamber of Commerce workers.

Russell Stephens, chairman of the oil and gas committee of the chamber, appointed the following subchairmen: R. B. Leach, J. C. Hunter, Jr., W. P. Wright, Walter Jarrett, Vic Behrens, Charles Lacy, Elbert E. Hall.

Canadian Gas Association Annual Convention

The thirty-second annual convention of the Canadian Gas Association will be held in Hamilton, Ontario, June 6-7, 1939, at the Royal Connaught Hotel. It is expected that much of interest and practical value to the gas industry of Canada will be on the program, and members desiring any particular subject to be discussed, of general interest, are asked to notify the secretary at an early date.

CALENDAR

December.

MID-CONTINENT OIL AND GAS ASSOCIATION, Standing Tax Committees, Dallas, Tex., Dec. 1-2.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, Dec. 5-9.

POWER & MECHANICAL ENGINEERING, thirteenth national exposition, Grand Central Palace, New York, December 5-10.

OIL AND GAS ASSOCIATION OF MICHIGAN, annual meeting, Mount Pleasant, Mich., Dec. 7.

WEST CENTRAL TEXAS OIL AND GAS ASSOCIATION, annual meeting, Abilene, Tex., Dec. 10.

January, 1939.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting, Detroit, Mich., Jan. 9-13.

February.

NATIONAL ASPHALT CONFERENCE, Los Angeles, Calif., week of February 27.

March.

AMERICAN SOCIETY FOR TESTING MATERIALS, committee week and regional meeting, Deshler-Wallick Hotel, Columbus, Ohio, Mar. 6-10.

INDIANA INDEPENDENT PETROLEUM ASSOCIATION, spring convention, Hotel Severin, Indianapolis, March 14-16.

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, annual meeting, Oklahoma City, Okla., March 22-24.

April.

AMERICAN CHEMICAL SOCIETY, Baltimore, Md., April 3-7.

NATIONAL PETROLEUM ASSOCIATION, semi-annual meeting, Hotel Cleveland, Cleveland, Ohio, April 13-14.

OIL-WORLD EXPOSITION, Houston, Tex., April 24-29.

May.

PETROLEUM ELECTRIC SUPPLY ASSOCIATION, Houston, Tex., May 2-4.

PETROLEUM INDUSTRY ELECTRICAL ASSOCIATION, Rice Hotel, Houston, Tex., May 2-4.

THE OIL INDUSTRY

A Living Monument to the American System of Free Enterprise

By
J. Howard Pew
President, Sun Oil Co.*

J. HOWARD PEW

When I accepted the invitation to speak here today it was in my mind to make the orthodox address, beginning with the announcement that our industry confronts a crisis and then advising as to what we should do about it. Ever since I can remember, we have been hearing that a crisis was upon us. That has been our experience so long that it would be a lonesome business to meet in annual convention and not have our crisis with us. Most commonly, our critics have attributed the crisis to competitive conditions; one group insisting there was too much competition, the other that there was not enough. Whichever it was, they could at least agree that because of it the industry was in a bad way. Half the diagnosticians believe the industry is insanely competitive; the other half believe it has throttled competition and become an unholy monopoly.

Personally, I accept neither diagnosis. I think we have plenty of competition. I think it is good for us. Unfortunately, the judicial and legislative surgeons have the last guess.

Rapid Development

Because it seems unavoidable in a logical presentation, I wish at the outset to note briefly some facts with which all of us are familiar. If the industry deserves to be branded as a monopoly, there must be some evidence of its monopolistic character. If our prices were excessive there would be innumerable complaints. Yet in all the investigations of the industry the thing that has most impressed me is that our customers never allege that we are over-charging them. More commonly they wonder that our products are so cheap.

Our products scrape the bottom of the commodity price index. Thus in June, 1938, they stood at 56.3 as against 78.3 for "all commodities." And they have in recent years shown the greatest shrinkage in consumer price. In 1920 the country's average service station price of gasoline, ex-tax, was 29.74 cents. In 1926 it was 20.97 cents. Now, 1926 is commonly accepted as the post-war year of best equilibrium in prices. Well, if the 1926 price of gasoline, 20.97 cents, was fair, then there certainly can be little consumer complaint, because since 1926 it has fallen until on October 1, 1938, the national average was 13.76 cents—of course exclusive of gasoline tax—and the lower price paid for a much higher quality of motor fuel. The index shows petroleum products today the cheapest commodities of general use.

Why then should suspicion point toward us in any discussion of monopoly? An analysis of the earnings of oil companies from 1921 and 1936 shows that the industry had deficits in four years and profits in 12. The highest yearly return on capital was 4.96 per cent; average yearly earnings were 1.357 per cent. It would be a mighty inefficient monopoly that could do no better than that!

But, even if prices are low and profits modest, is there some phase subject to criticism? Is it our attitude toward labor? A favorite diversion of monopoly is supposed to be grinding the face of labor. So let us inquire how this industry has been treating its workers.

Department of Labor statistics say that in 1937 the payrolls of oil refining exceeded 1929 by over $20,000,000. The average hourly refinery pay in 1937 was 97.2 cents which was more than 50 per cent above 1929, and the highest rate paid in any manufacturing industry. Weekly working hours averaged 49 in 1929 and 37 in 1937; but the average weekly wage in 1937—$35.67—was higher than in 1929 and almost $10 more than the average for all industrial workers. The refining industry showed one of the lowest rates of labor turnover, and there were 7½ per cent more employes in 1936 than in 1927. If all business had kept that pace there would be no unemployment problems today. The oil industry has been *lifting* the face of labor, rather than grinding it.

Summarizing our search for the stigmata of monopoly, we find that the oil industry charges the lowest prices for its products, pays the highest wages, increases employment right through the depression period—and earns less return on its capital than it would if that capital were invested in Government bonds. The stigmata of monopoly just are not there!

The petroleum industry has been built around the theory of big and expanding production at low and constantly lower prices. It is not only our biggest single industry, but it is our most impressive monument to the efficacy of unstinted competition. I mean the kind of competition that is always looking for better methods, improved processes, invention, discovery—that seizes upon every new idea looking to lower costs, better products, wider markets—that always gives the consumer the benefit of better goods at lower prices. It is the kind of competition that has demanded millions every year for work in laboratories and experimental plants—that has endowed scientific study and tireless research.

From one point of view it has been expensive competition, for it has demanded a constant reorganization and modernization of plants and processes to keep them in step. The establishment that is today's last word in progress, and has cost millions, is likely to be outmoded by next year: it must be brought up to date on pain of being elbowed out of the race. Yet this seeming wastefulness is in truth the essence of sound industrial economy. The fraction of a cent of saving per gallon, or the shade of improvement in quality, is quickly multiplied into wider acceptance, expanding volume, and strengthened position. These are the things which keep us constantly on the keen edge of competition, and which make competition a good thing.

Stigmata of Monopoly

Looking beyond the horizons of our own particular industry, I think we may emphasize this point by a brief consideration of the entire automotive group, among which petroleum is only one. This group most characteristically typifies the industrial trends of the present century. Casual recollection of horse-and-buggy days must impress how sweeping has been the revolution in manners of life and methods of industry. And the most striking thing about this automotive development has been its competitive character.

In that competition we have seen how the rugged individualist, Henry Ford, sturdily independent of finance capitalism, stock market appeal, or banking support, has found his place, maintained his independence, and reared an industrial structure that is one of the wonders of the business world. Yet right alongside of Henry Ford we have seen a score of great corporate concerns raising their capital from millions of investors and building up the same kind of business to the same pinnacle of success in the entirely different atmosphere of corporate organization.

So we see that within our American system of

*From address before American Petroleum Institute at Chicago.

free enterprise there is always room, side by side, for colossal units of individual enterprise and towering structures of corporate organization. At the end of 1937, General Motors Corp. was owned by 375,755 stockholders; the Ford business by three. So long as such widely divergent types can grow and flourish, monopoly will be impossible.

If I may be pardoned a personal allusion in this connection, I think the experience of my own company, though on a much smaller scale, illustrates the same point. By comparison with many of the greater corporate units in the petroleum industry, the Sun Oil Co. is quite a modest little affair. Both its controlling ownership and its management have always been held within a single family. Its operations represent about 3 per cent of the country's petroleum industry, so I rate myself as a "small business man." Now, it is only about 13 years since we produced and marketed gasoline. At that time the industry, as we promptly learned, had grown to full adult stature; and we were left no room to doubt that it was thoroughly competitive. Nevertheless, our hopeful little enterprise was able to make a place for itself. We found no monopoly to freeze us out, and no excesses of competition to starve us out. We have never assumed a divine right to a place and a share in the industry. If somebody else could serve the public better in quality or price, he was entitled to the business. That is still our attitude, and the attitude of the industry. Everybody has recognized that his right to continue in business depends on his ability to give the public what it wants at prices it is both able and willing to pay. To live up to that formula has kept all of us scratching. It has been a case of root hog or die, and my agricultural friends tell me that the most vigorous rooter is usually the healthiest hog.

The automotive industries have served the public well. They are free from monopoly, and competition has been a chief factor. Nevertheless, there is demand for government to invade the oil industry's field with measures which, under the guise of helpful "regulation," would before long develop the paralyzing rigidities of government control.

Real Crisis

It is at this point that we descry the real crisis that menaces the oil industry. On one side are those who believe in limiting the size of corporate units, and who demand such limitations. On the other side are those who raise the question whether, in present-day conditions, large units are not only necessary, but sometimes afford the best insurance against monopoly, the soundest guarantee of effective competition, and the surest protection of labor's rights.

My own feeling is that if the great concerns can operate in the general interest, within our free enterprise system, then they should not be molested merely because of their size. But I strongly feel that we must foster the smaller units and give them such encouragement that they will always be part of our system. The small units of today will be the big units of tomorrow. Through them industry and enterprise must receive constant infusion of new blood, new talent, new energy and ever-widening outlook. We must have the smaller units as well as the larger, complementing each other, and together giving us a properly rounded and coordinated business structure. The discouragement of small business would shortly precipitate conditions in which all enterprise would be smothered.

I hope Senator O'Mahoney's Temporary National Economic Committee will thoroughly study all the evidence in these regards. Such a study, I am confident, will refute the theory entertained by some people that a few big oil companies dominate the market and fix prices. That is constantly disproved in day-by-day experience.

I have been at pains to inform myself about the experience of some large companies which have been in the gasoline business a good deal longer than I have. These companies all testify that while their *volume* of business has grown, their percentage of the *total business* has greatly shrunk through the years. How did it happen? The answer is that a good many of the small companies of 10, 20 and 30 years ago have been getting increasing shares at the expense of the so-called "market leaders." Year by year leadership in either volume or price has tended to be diffused rather than concentrated; and that is another phase on which I hope the Temporary National Economic Committee will thoroughly inform itself, the public, and the law-makers.

Question of Size

The instances just cited bring us back to the debate over whether there is an economic point beyond which the size of the industrial unit cannot grow. Personally, I think there is. Too wide a diffusion of managerial authority and responsibility carries with it the danger of a complexity of red tape, of weakening authority, and, in the vernacular, too much buck-passing. This point may vary greatly with different industries and organizations; but I am convinced that there is such a point; and that fact is a chief guarantee that there will always be room for the new ambitious, energetic and resourceful enterprises.

I think there will be little dissent from the view that if natural economic forces are adequate to keep business on a sound basis, there is no occasion for governmental interference. I mean *sound* from the standpoint of all concerned—owners, labor, management, customers and the public. Only when natural economic forces fail is there justification for governmental regulation —and then for only the minimum of regulation necessary to reestablish the sound basis.

Let me be quite clear on this matter. It is proper for government to lay down general rules to preserve competition, to prevent monopoly, to enforce sound business ethics. Having laid them down, government should enforce them. But when the arm of government is thrust into the intimate workings of business, when government undertakes to dictate policy, to fix prices, to interfere with the very competition which it assumes to be protecting then we have government *control;* and that is inevitably paralyzing to initiative, invention, adventure, and enterprise.

Regulation may impose rules, to be enforced through the courts; but that is different from the *control* which enters the picture when a board, or commission, or other administrative authority is vested with managerial discretion, and, from the inside of the business structure, exercises at once the functions of the judicial, the administrative and the executive agencies. That is the domination that our ardent economic planners would have government exercise; the domination in which will be written the death sentence of free enterprise.

We may speculate with some interest as to what might have been the attitude of a National Planning Board in 1900, if one had existed at that time, toward the automobile and petroleum industries. There were then in operation in this country some 8,000 motor cars, consuming 80,000 bbls. of gasoline in a year. That is just about enough gasoline to keep the cars of today in operation for one hour and a half. Let us imagine Mr. Ford, with his great vision of the automobile's future, appearing before that board and asking that in its program for the next two or three decades it provide a few billions of dollars of capital, along with the necessary labor and material, for his industry. The board would have recognized in Mr. Ford a mild lunatic. They would have asked him where he expected to get the gasoline for all those cars; and would have pointed out that neither the gasoline nor the crude oil from which to make it was anywhere in sight. And they would have rejected Mr. Ford's demands. A sophisticated public would have laughed at Ford when the board set down genius as insanity and inventive ability as lunacy; and that would have ended all foolish talk about horseless carriages and flying machines.

But fortunately for those 20,000,000 families in this country who derive pleasure and satisfaction from the operation of their cars, there was no such board in 1900. And so Mr. Ford, not worrying about where his gasoline was coming from, went right ahead building more cars and better cars, until presently he was turning out over 1,000,000 cars a year.

Fortunately also for the oil industry, there was no such board, for the industry went right ahead drilling more wells and deeper wells, and sometimes finding oil. Oil men brought technology to their assistance in the form of geology and geophysics, and by their aid discovered new oil fields. In order to get the gasoline into the consumer's car at the lowest possible cost, they built tens of thousands of miles of pipe lines which carried the crude oil from the wells and stored it at central points. They invented, developed, and built hundreds of great tank steamers, which have now become the lowest cost transportation units in the world. They built finer, larger, more complex and more efficient refineries; and they built more pipe lines to take the gasoline from the refineries, where it was eventually loaded into tank trucks and delivered to those hundreds of thousands of filling stations throughout the land. And so the oil industry, doing each year these things which would have been impossible the year before, was always able to keep just a step ahead of the thirst for gasoline of those multiplying millions of automobiles.

The American System

In conclusion, I appeal to you men of this great industry to stand firm in defense of the American system of free and competitive enterprise. The truth is that no economic planning authority could ever have foreseen, planned, plotted, and organized such an amazing spectacle of industrial progress as the world has witnessed in the last century. No trust or combination, private or governmental could have accomplished it. It could have been achieved only under conditions of wide open invitation to all the genius, inventive ability, organizing capacity, and managerial skill of a great people.

Nobody must be barred, no invention rejected, no idea untried; everyone must have his chance; and under our American system of free enterprise and equal opportunity everybody gets just that chance. It is our freedom that has brought us to this high estate—intellectual freedom, religious freedom, political freedom, industrial freedom; freedom to dream, to think, to imagine, to experiment, to invent, to match wits in friendly competition; freedom to be an individual.

When a people come to look upon their government as the source of all their rights, there will surely come a time when they will look upon that same government as the source of all their wrongs. That is the history of all planned, dictated economies. That is the history of tyranny. To each of us is assigned a part to play in the great drama of life; and we can only play our parts with the greatest measure of perfection as free, unhampered individuals. Surely it is not thinkable that, in the light which shows through this twentieth century, a great progressive people will be beguiled into turning back to the ways of controlled economies and dictated social programs.

STATE CAPITALS

TEXAS

TEXAS OIL AND GAS RESERVES have been trebled by conservation, according to a statement of Col. E. O. Thompson, of the Railroad Commission of Texas, addressing the National Business Advisory Council of the U. S. Department of Commerce, at a meeting in Houston.

"Not only have we produced twice as much as the experts said we had in 1925," he observed, "but technical advance of refining has made it possible for us to get nearly twice as many gallons of gasoline out of a barrel of oil as we did in 1925."

"We believe that we have made a business out of the production of oil—what the older among us remember as 'the oil game'."

Proof of this, he said, was in the fact that oil-producing properties today are welcomed by Texas bankers as security for loans.

"Bankers know that oil in the ground is as good as money in the bank, so long as sane, sensible management governs its withdrawal," Colonel Thompson said.

Reports of the Bureau of Business Research at Texas University were cited as authority for the statement that the state's income from oil is equal to the income from all agricultural activities, thus ranking oil as the most important productive activity of the state.

ALLOWABLE PRODUCTION IN TEXAS IN DECEMBER will be the subject of a meeting of producers, buyers and the Texas Railroad Commission at Austin on Friday, November 18. There are indications that the two days a week shutdown of production will be continued through next month. East Texas crude purchasers have informed the commission that they will cooperate in efforts to furnish outlets for the oil produced by about 500 wells in the big field which are now without connections, provided the five-day producing week be continued.

POSSIBILITY OF REPEALING the provision of Texas' motor fuel law which provides an exemption on all purchases of gasoline intended for use other than in vehicles on highways was seen in the coming session of the state legislature. Comptroller George H. Sheppard's annual report shows that $6,871,362 in gasoline taxes was collected and refunded during the past fiscal year, representing 13.9 per cent of all that collected. His analysis shows that the biggest beneficiaries of the refund law are farmers.

As long as the tax has been assessed, 25 per cent has gone into the available school fund, hence motorists have been made to pay additional tax of 1 cent per gallon to this fund. A few years ago, another cent of the gasoline tax was set aside for the retirement of bonds issued by local road districts and counties. Ordinarily, these would have had to be paid by ad valorem taxes against the property owners in the district or county. Thus the motorist is required not only to take over this tax burden, but other users of gasoline, many of whom theoretically benefited in decreased ad valorem taxes, are specifically exempted from paying it.

SOLUTION OF THE EAST TEXAS SALT WATER DISPOSAL problem was seen as possible following the hearing last week at which Sun Oil Co. asked the Railroad Commission for permission to use its No. 38 H. A. Pace in Juan Vargas Survey, Smith County, as a salt water disposal well. While mechanical aspects of the plan were relatively simple, possible legal complications were foreseen. If these fail to arise or can be overcome, then it is possible that much East Texas water may be piped to the west side of the field and dumped into a few wells there. Principal question was whether owners of offsetting leases might object to having salt water dumped into wells so near their leases. The well was recently subjected to experimental operations by Sun when it was used as a disposal well for salt water from the Pace lease. An attempt was made to return the water to the Woodbine formation without permitting it to be exposed to air, thereby preventing precipitation of various iron salts which might clog pipes and sand surfaces.

REFINERY OPERATIONS in Texas will be considered by the Railroad Commission at its state-wide proration hearing November 18, with a view to making the information available to the legislature when it meets in January in considering an amendment to the oil proration law. The aim is to bring refineries within regulatory scope of the commission.

ILLINOIS

SUGGESTIONS FOR THE ABATEMENT and prevention of pollution of Lake Centralia and other waters in the Illinois oil fields are contained in a series of pointers passed out to oil operators and others by A. P. Troemper of the division of sanitary engineer, state Department of Public Health.

"Adequate facilities should be provided for collecting and holding all petroleum wastes until they may be finally disposed of," says Mr. Troemper in concluding his message to producers. "The most satisfactory method of disposal of brine appears to be by returning it to geological formations. Strict vigilance on the part of employes entrusted with the responsibility of handling oil-field wastes will be one of the most important contributing factors to the success of the system adopted. The Sanitary Water Board expects that proper disposition will be voluntarily made of the wastes created on each oil-producing lease and in such manner as to prevent objectionable pollution of Illinois streams. Continued objectionable pollution will constitute just cause for definite action being taken against offending parties in accordance with the Sanitary Water Board law."

OKLAHOMA

ALLOWABLE PRODUCTION IN DECEMBER will come before the Oklahoma Corporation Commission on November 29 for discussion and action. On that day also hearings will be held on two petitions by W. J. Armstrong, chief corporation officer. One provides for rules for potentials on wells in the Wilcox zone of the Oklahoma City field for the January, 1939, period. The other is for taking potentials on wells and leases in Class B fields, also to be effective in January.

KANSAS

THE KANSAS CORPORATION COMMISSION has fixed November 25 as the date for its hearing on allowable production in the state in December. Purchasers have been requested to make known their requirements for December by November 22.

On November 25, at 1:30 p.m., the market demand for gas from the Hugoton field and from the Burrton field will be determined.

STANOLIND OIL & GAS CO. has petitioned for an adjustment of potentials in the Zenith pool in Stafford County and for a uniform method of taking potentials in the pool, and the Palmer Oil Corp. has made application for an increase in allowable in the North Beaver pool, Township 16s-12w, Barton County, and these will be considered at the meeting on November 25. The Corporation Commission has advised interested producers that the rehearing on the Habiger-Arbuckle market demand will also be heard on the date above given, also the matter of the application of H. B. Garden and others for a rehearing on the revision of production percentages made under previous conservation order No. 38-08-27 and their application for a rehearing on the revision of the general rules applying to conservation and ratable production of crude oil and natural gas, plugging of wells, underground disposal of salt water and repressuring of and waterflooding. The commission has given itself a big program at the coming meeting.

A HEARING ON CONDITIONS of the stripper well industry in eastern Kansas, originally scheduled to be held before the Corporation Commission in Wichita last Friday, has been postponed until November 28, when it will be held at Independence. Operators of wells in the stripper districts requested the hearing after Sinclair Prairie Oil Co., principal buyer in the district, announced it would discontinue taking oil from some of the wells on November 15. The company later agreed to continue buying the oil pending the hearing.

Allowable schedules fixing November gas production at 1,100,000,000 feet for Otis field of Rush and Barton counties and 140,000,000 feet for the Burrton field in Reno and Harvey counties have been mailed to operators by the Corporation Commission.

CALIFORNIA

PRODUCTION CURTAILMENT in California remained in status quo during the past week with the result that actual production continued well in excess of the prescribed quota. All major companies have reduced drilling operations to a minimum, which will reduce the amount of new production to be absorbed, and will make the problem of the Central Committee somewhat easier. Reduced drilling is the result of a survey conducted by the Central Committee at the insistence of A. C. Rubel a few months ago, who pointed out that the excessive amount of new production being added each month was defeating the primary purpose of curtailment. The reduction effected is very pronounced in the Greeley, Ten Section and Rio Bravo fields. Operators in the Santa Maria Valley field convinced landowners that a continuance of drilling in that district was sure to set the field back perhaps a year from a production standpoint. Landowners held several meetings and approved the recommendation of operators. As a result of this, buyers agreed to take a total of not to exceed 10,000 bbls. per day out of the field. The first month under this agreement has just expired, and since actual production approximated the allowable, all indications point to a continuance of the agreement.

PRESIDENT'S ADDRESS

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or enlargements will improve its usefulness. It is not necessary or, in my opinion, wise to come to a final decision on these matters. Study and discussion should continue, but I cannot refrain from here commenting that I doubt whether an agreement giving the Compact Commission mandatory powers is either legal, practicable or desirable. A sovereign state is not permitted to surrender its police power. Such power can only be used incident to the conservation of petroleum by the individual state in regard to drilling permits, well-spacing, sound engineering practices and well production allowables, in such ways as to do equity and prevent waste. The usefulness, influence and strength of the Interstate Compact rest upon the democratic processes of study, discussion, education and moral influence. Nor can I see why any producing state which desires to serve the general interests and safeguard its own should hesitate to join and sit at the conference table.

The industry is now in one of its periods of discontent as a result of lower price levels. It is my personal opinion that the situation is not as serious, or does it promise to be as protracted, as many like situations have been in the past, excepting for one factor, namely, a greatly increased tendency to expect relief from Government for every uncomfortable or unprofitable condition, whether of our own or someone's else making, and whether known to be temporary or believed to be permanent.

Experience Safe Guide

These particular times and circumstances give birth to many ideas and suggestions. Might it not be well to remember that the instructions of experience are far safer guides than declarations of abstract idealism; that small initial variations from sound principles often lead to astonishingly different ultimate results than those anticipated. Without intending to be critical of anyone, it may not be improper to cite an old expression, namely, that those who indulge in wild notions often fly high and light low. The whole point I am trying to make is that the easy way is often the wrong way, and that sometimes the prescription harms the patient more than it could possibly help him. In connection with the study of the various proposals it may not be amiss for us to pause and view what is right with the oil industry while we are considering what is wrong with it.

From the standpoint of service to the consumer, who is the public, there seems to be very little, if any, ground for complaint, or do we hear any. On the contrary, can anyone name an industry that has more efficiently or economically served the consumer? Some day, and the sooner the better, this story should be told in words of one syllable and emblazoned so that he who runs may read.

The industry from its beginning, three-quarters of a century ago, has found without interruption an adequate supply of an elusive and hidden raw material. Since the introduction of the internal combustion engine the growth of the oil business and its widespread service has been one of the miracles of the industrial age. Through the development and application of science, based upon ever-increasing factual data, to discovery and production of petroleum it has kept its proven reserves well ahead of the ever-mounting consumptive demand and, regardless of the occasional predictions to the contrary, which are as old as the industry, no well-informed person doubts that this industry will be able to do this for an indefinitely long time to come, before having to supplement its supply in any one of a number of known available and practical ways.

By the invention and adoption of its own unique methods of transportation it has reduced carrier costs to a minimum and, through the application of an ever-developing and expanding refinery technology, has almost unbelievably reduced the quantity of crude oil required to meet the growing demand for products. Thus it has conserved and extended the life of our petroleum supplies while constantly improving the quality of products, reducing their price and expanding service. At the same time it has provided wages and working conditions for labor second to none in any industry, and has contributed on property, processes and products to the support of Government approximately one-eighth of all of the taxes collected in the country. Last year the total tax bill paid by the industry, and by consumers, on its products, amounted to the staggering total of $1,343,000,000.

These things have been and are being accomplished without monopoly, either public or private, and with a minimum of governmental regulation or assistance while at the same time keeping the doors of opportunity wide open for those who wish to enter any department of the business. That they have done so and are continuing to do so is evidenced by the increasing thousands of so-called independent producers of petroleum, the tens of thousands of entrepreneurs in marketing and the many refineries which are built and commence operations wherever an operating profit is thought to be foreseen.

In the petroleum industry, as in all others, some fail and some succeed, but all engaged in it seem reluctant to forsake it for other lines of endeavor and that, presumably, because they feel that in this business, as good, or better, opportunity is offered as in any other.

In these circumstances does it not seem wise to carefully appraise both from the standpoint of those engaged in the industry, whatever their economic position or interest may be, as well as from the standpoint of the interest of the people as a whole, the various proposals which might disrupt its service to the nation, as well as the opportunity of those engaged in it. This is a great low-cost, mass production, integrated industry, which practically works on the assembly line plan from the geophysicists searching for underground reservoirs of petroleum through all the processes of production, transportation, refining, terminaling, bulk plants and retail stations, to serve the daily needs of 130,000,000 people in this country, and other millions throughout the world.

As a result of a federal investigation conducted about 20 years ago, it was predicted that the public would soon be paying $1 a gallon for gasoline. Other predictions as unfounded as this one are frequently made. Such is the stock in trade of the uninformed. At the risk of being included in the latter category, I will make a prediction, namely, that the way to double or treble the price of gasoline and other petroleum products is to adopt a few political panaceas as distinguished from obtaining wise governmental cooperation.

It is not my intention upon this occasion to enter into a discussion of the various remedies proposed, such as divorcement of pipe lines, the divorcement of marketing, or other steps which would lead to disruption and disintegration and add to consumer costs. The word, "integration," is here used in its generic sense and does not refer to so-called integrated companies. The whole industry, from the stripper well to the small so-called independent service station, is, after all, part of an integrated industry, each operator, whether large or small, participating in the daily flow of a veritable river of petroleum and its products from the widely scattered producing fields to more widely scattered consumptive markets.

Rather let each one carefully think out whether this step or that, if taken, would benefit or hurt him in the long run, or benefit or hurt the consumers, who are the nation, and upon the proper treatment of whom one's right to do business does and should depend.

It is difficult for anyone to envisage the complete economics of so vast, complicated and sensitive an undertaking as the petroleum industry. It is particularly difficult for one engaged in but one branch of the industry to see the effect which fulfillment of all his desires would have upon the other branches and consequently upon the whole undertaking, including himself. This leads me to remark that there is but one greater need for this industry than a campaign of sound, accurate and honest public relations, which would result in better public understanding. That greater need is for such a campaign in what we might term domestic relations for the education of those engaged in the industry itself.

The opportunities which have come to those engaged in this business for its service to the public, have come as a result of a free competitive system. Competition often hurts, but at the same time it, and it alone provides opportunity for the individual and progress for the nation. If at times, in our distress, we are inclined to doubt this, let us reflect for a moment on what our opportunities would be, or what the fate of the nation would be, under either bureaucratic or totalitarian regimes. Unless I mistake the spirit and character of the men who make up this industry, they are likely to keep their feet on the ground and continue to fight for free economy and a free industry.

The function and role of government, as I see it, is to lay down the rules of the game and thereafter to act as an impartial referee, seeing to it that the rules are obeyed—the game itself to be played within those rules by men permitted to exercise their own initiative and their own ingenuity as free men only can. Thus and thus alone is progress made and do men grow strong and nations great.

TRINIDAD

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4. The Southern Basin is a broad, low valley slightly more undulating than the Northern Range. The greatest elevation in the Southern Basin is not over 250 feet above sea level. At the northeastern end of the Southern Basin, and fronting on the Atlantic, is an impenetrable swamp known as Navira Swamp, and at the western end of the basin is the flask-shaped Oropouche Lagoon, which is connected by a narrow neck to the Gulf of Paria.

(*a*) Navira Swamp, into which the major drainage of the western part of the Southern Basin flows, is the largest inundated area on the island. A great amount of work will be necessary if an attempt is made to reclaim this swamp.

(*b*) Oropouche Lagoon, which receives much of the drainage from the western part of the Southern Basin, is in part open water—the flooded channel of the Godineau River which is surrounded by extensive mangrove tidal swamps. These swamps have possibilities of being reclaimed.

5. The Southern Range forms a rugged barrier to the Atlantic Ocean on the south side of the island. Though only between 500 and 1,000 feet above sea level, parts of it are practically unexplored because of the dense jungle, which blankets the rugged topography and because of the absence of communication routes.

A. P. I. SIDELIGHTS

Why Automobiles Differ in Motor Fuel Requirements

A few of the many answers to the question why modern automobiles of the same make and model, and apparently in the same operating condition, differ so greatly in motor fuel requirements were placed before the American Petroleum Institute's annual meeting.

The situation was ascribed chiefly to variations in spark-advance settings of the individual cylinders of the various motors, and to the variation of mixture-strength of fuel reaching the cylinders. Variations are so great, it was reported, as to provide evidence that modern automotive design is not capitalizing upon the continued efforts of the petroleum industry to provide fuels of better volatility and higher octane number. It was said that care in assembling cars at the factory could bring about a decrease in motor fuel octane requirements, a factor which might be utilized in future designs to permit of higher compression ratio and increased efficiency.

The situation was discussed by A. J. Blackwood, O. G. Lewis, and C. B. Kass, all of Standard Oil Development Co. Revealing findings in research into the anti-knock and mixture-distribution problem in multicylinder engines, they expressed the hope that such research might inspire developments looking to improvement of existing conditions by engine manufacturers.

"The wide differences found in the octane-number requirements of individual cylinders," they said, "plus the failure to obtain uniform mixture distribution from cylinder to cylinder without resorting to fuels of aviation-grade volatility, make it appear that present-day cars are not capitalizing on the continued efforts of the petroleum industry to provide fuels of better volatility and higher octane number. Precautionary measures might be included in the assembly of the engine at the factory to insure that the cylinders normally receiving fuel mixtures most likely to detonate do not receive simultaneously the greatest spark advance. This should result in a decrease of several points in octane-number requirement which, in turn, could be utilized in future designs to permit of higher compression ratio and increased efficiency."

Favorable Progress Reported On Research Program

Unusually favorable progress was reported on the fundamental research program sponsored by the American Petroleum Institute at the University of Ohio. There the antiknocking characteristics of pure hydrocarbons are being systematically investigated and cataloged with the view of ultimately designating the one or series of hydrocarbons that may be most efficiently manufactured and utilized as motor fuel. Engine performance could be greatly improved and octane values of such fuels could reach 150 in contrast with 100 on the best grades of aviation gasoline at present.

Improved Safety Practices In Petroleum Industry

Substantial decline in the number of accidents which take lives and cause severe injuries, made possible by improved safe operating practices in the petroleum industry, was recognized at the first general session of the American Petroleum Institute meeting. Executive Vice President W. R. Boyd, Jr., presented to oil company representatives 76 accident-prevention certificates signalizing accomplishment in establishing low accident-frequency, accident-severity, and injury-index records.

Safe operation of its Whiting, Ind., refinery for 11,274,866 hours brought a special certificate to the Standard Oil Co. (Indiana), increasing to 17 the number of Institute safety awards won by this department, which has established five 1,000,000-hour records since January 1, 1937.

Mr. Boyd explained that the rigid requirements of the awards demanded recognition of minor accidents causing as little as one day's lost working time, and pointed out that the cooperation of the companies in reporting their records to the Institute greatly had advanced the work of accident prevention. Both frequency of fatal injuries and severity of injuries declined 12 per cent during 1937, he said, and reports so far available indicate continued improvement for 1938.

New Soil-Surface Sampling Discloses Gas-Oil Ratio

A new method of revealing nature's secrets whereby certain characteristics of crude oil in a pool thousands of feet below the surface of the earth may be ascertained in advance of production, and producing methods may be altered to meet the needs of the situation, was described before the Division of Production by D. L. Katz of the University of Michigan.

The new method, known as "subsurface sampling," is of help not only in solving production problems, but serves as an alternate method of estimating the amount of oil in a pool. He said the method also discloses the gas-oil ratio of the crude, as well as the natural gasoline content, and permits the location and identification of horizons.

J. L. Shakely Chosen President of Suppliers Association

J. L. Shakely, president of the Frick-Reid Supply Co., Tulsa, was elected president of the Petroleum Equipment Suppliers Association. E. S. Dulin, president of Byron Jackson Co., Los Angeles, Calif., was made vice president, and Wharton Weems, of Houston, Tex., was reelected executive secretary and counsel.

J. L. SHAKELY

Flexibility of Houdry Processes Adapted to Varying Conditions

The Houdry processes were described in a paper presented jointly before the Division of Refining group session by Eugene Houdry, of Houdry Process Corp., Wilmington, Del.; Wilbur F. Burt, of Socony-Vacuum Oil Co., Inc., New York, N. Y.; A. E. Pew, Jr., of Sun Oil Co., Philadelphia, Pa., and W. A. Peters, Jr., of E. B. Badger & Sons Co., Boston, Mass. Refining operations under the processes, now covered by 96 United States patents, were developed by Socony-Vacuum Oil Co., Inc., and Sun Oil Co., in conjunction with the Houdry Process Corp. and are controlled by that corporation, which is jointly owned by the two companies and by Mr. Houdry and associates.

In describing the processes, the sponsors emphasized the flexibility of operations. A 45 per cent yield of 77-81 octane gasoline from single-pass operation on any stock was reported, and the sponsors said that refining of 7,000,000 gallons of aviation gasoline in 1937-1938 represented the first commercial application of a synthetic process for aviation-fuel manufacture. Finished aviation fuel was said to show 76-78 octane numbers, 87 to 92 octane with tetraethyl lead added, and 100 octane when blended with such antiknock agents as isopentane and isooctane. It was pointed out that with a typical 100-octane Army-method blend, only one-half as much isooctane is required as with natural aviation gasoline from selected crude. It was emphasized that, since finished products consist entirely of gas, gasoline, and gas oils, heavy fuel oil production is eliminated. Also, the type of crude used substantially has no effect on yield or octane number of gasoline produced, and sulfur content of gasoline produced is remarkably low.

The ends of conservation of the nation's petroleum reserves are served by the new processes, it was reported, by their ability economically to refine any type of crude oil tending to make available for use many types of crude oil currently unsuited for conventional refining operations.

Price Posting and Fair Trade Laws Marketers' Topic

Price-posting and fair-trade laws are more desirable than government control and state regulation in meeting the current needs of the marketing branch of the petroleum industry, President Wilmer R. Schuh, of the National Association of Petroleum Retailers, Milwaukee, Wis., said in an address before the American Petroleum Institute's nineteenth annual meeting here today.

More varied and expert merchandising at service stations was recommended by Leon A. Bosch, of Northwestern University school of commerce, Evanston, Ill., who also addressed the Institute's Division of Marketing group session.

"We have studied many other cures advanced by various groups," said Mr. Schuh, "such as government control, state regulation, fair-trade laws, etc., and after thorough investigation we have decided that the only regulatory laws that are desirable are price-posting laws, which are more of a protection to the public than they are to us, and the so-called fair-trade laws, which laws are very effective, at least in some instances, as an aid to straightening out a completely demoralized market. You can see by the foregoing that we are by no means rugged individualists, but we do believe that we not only should, but must, get along with a minimum amount of help from the governmental agencies and we will fight to the last ditch to prevent politicians from taking control of this industry. The petroleum industry's record today, we believe, is the best argument for free enterprise."

Pointing out that selective selling has been a profitable practice in other industries, Mr. Bosch said the extended retail structure in the petroleum industry could be relieved by more selective selling effort on the part of refiners generally.

Pipe Line Activity

Rocky Mountain Pipe Line Co. Tests Lance Creek Line

DENVER, Colo.—The test run of the Rocky Mountain Pipe Line Co.'s 230-mile Lance Creek-Denver line has been completed. It has a maximum capacity of 10,000 bbls. daily and at the start 5,000 to 6,000 bbls. of crude daily will be moved to the Denver refinery of Continental Oil Co., and the Cheyenne, Wyo., and Denver plants of Bay Petroleum Corp.

Construction of the line was begun August 22 and it was completed October 29. There are three pumping stations, one at the field, and booster stations at Guernsey and Cheyenne, Wyo. The 136-mile line, connecting the Lance Creek field with Cheyenne, is of 8-inch pipe. The 96-mile link between Cheyenne and Denver is 6-inch.

The company also recently completed its Lance Creek-Glenrock line to the refinery of Continental Oil Co. W. H. Ferguson, vice president of Continental Oil Co., is president of the pipe line company. Other officers include C. U. Bay, of Bay Petroleum Corp., which holds 25 per cent of the stock, and Fred Goodstein, of Minnelusa Oil Corp., which controls 20 per cent.

Carnegie Gas Company To Lay $600,000 Line

UNIONTOWN, Pa.—The Carnegie Gas Co. will build a $600,000 pipe line to connect the new natural gas field around the Summit Hotel with existing pipe lines at Waynesburg. The new line will run a minimum of 18 inches underground.

Hearing Held on Abandonment Of Cedar Creek Pipe Line

AUSTIN, Tex.—Hearing on the proposed abandonment of Bastrop Pipe Line Co. pipe line in the Cedar Creek field of Bastrop County was held by the Railroad Commission last week with the only objection coming from an owner of an oil payment. Shipments through the line have been intermittent and the line will be taken up and sold if the commission grants permission. Evidence was presented to show the line was not a common carrier, but that each of the three producers who have shipped over it in the past pumped their own oil through the line.

Pipe Line From Lake Centralia To Lawrenceville Is Completed

The Texas Pipe Line Co.'s 10-inch and 8-inch line from the Lake Centralia-Salem area in Marion County, Illinois, to the Indian Refining Co.'s plant in Lawrenceville, in Lawrence County, Illinois, about 80 miles distant, air line, is completed and is running oil. The line starts with 8-inch pipe from the field to the Clay County line where it becomes a 10-inch line to the refinery. Only one pump station is in use at present and the line can handle from 20,000 to 25,000 bbls. of oil per day, but with two pump stations it will have a capacity of over 50,000 bbls. per day. The capacity of the refinery is 16,000 bbls. of crude per day.

Pipe Lines File Protests At I.C.C. Hearings

WASHINGTON, D. C.—Pipe line company representatives testified at Commissioner Aitchison's hearings last week that their revenues in 1937 were from 14 to 50 per cent less than in 1933, the volume being much less.

W. R. Finney, president of Oklahoma Pipe Line Co., said his company is operating at less than 25 per cent of capacity and losing money at the rate of $650,000 annually. New production in Illinois, Kentucky, and Michigan have affected northbound shipments. Reduction in rates had been tried but lower rates could not help unless volume was added.

Accountants' reports showed Oklahoma Pipe Line revenues were 23 per cent less than they would have been at 1933 rates, and Ajax revenues 48.5 per cent less. Revenues of Texas Pipe Line, Texas Pipe Line of Oklahoma, and Texas Empire were 23, 28, and 14 per cent under 1933.

Examiner J. Paul Kelley of the I.C.C. has recommended a 35 per cent rate reduction and reducing minimum tender from 100,000 bbls. to 10,000 bbls., which company witnesses said would increase the percentage of contamination.

Natural Gas News

Industrial Use of Gas Engines For Power in Many Fields

Citing the 1936 and 1937 sales records of nine representative manufacturers of gas engines, E. P. Kramer, Atlanta, Ga., Gas Light Co., reported to the industrial gas section of the American Gas Association, recently in convention in Atlantic City, that "The use of gas with internal combustion engines to produce power has continued to advance most encouragingly throughout the country." Mr. Kramer is chairman of a committee of 10 experts on gas engine power which has spent two years analyzing the new trend towards the use of metered gas to develop motive and electric power for wide varieties of industrial uses.

The nine gas engine manufacturers who supplied the committee with complete data, sold, in 1936, 290 gas engines capable of developing 37,900 hp. In 1937, these companies sold 524 units representing 67,257 hp.—an increase of 77.5 per cent. With regard to the uses to which this gas-developed motive power is put: 10 per cent runs electric generators, 68 per cent operates air compressors, 2 per cent moves cotton gins and cottonseed oil mills, 5 per cent powers air conditioning and ice plants, and 15 per cent goes for pumping and other purposes.

From data supplied by gas companies, it was learned that in southern California there is used between 400,000 and 500,000 hp. from internal combustion engines operating on gas fuel. In the southwest the use of gas in internal combustion engines is on an even greater scale. Oklahoma Natural Gas Co. alone has over 27,000 hp. connected for industrial and commercial power purposes. The Lone Star Gas system boasts in excess of 50,000 hp. Other gas companies which have received natural gas in the past few years (for example, Peoples Gas, Light & Coke Co., Chicago, and Michigan Consolidated Gas Co., Detroit) are profiting by the experience of the older natural gas companies, and are developing the gas engine power end of their business.

In the operation of natural gas engines, the report says, a relatively small percentage of the total heat in the fuel consumed is utilized in useful work. The average natural gas engine has a thermal efficiency, in operation, of approximately 25 per cent. The remaining heat is dissipated in jacket cooling water, radiation, friction, and exhaust gases. The heat in the engine jacket water and the exhaust gases represents nearly 65 per cent of the total heat value of the fuel. This may be reclaimed, in large measure by the use of heat exchangers for jacket water cooling plus water jacketing of the exhaust lines from the engine.

In addition to waste heat utilization, another field for helpful and needed investigations concerning gas for power production is "along the line of the more economical loading of gas engines by an arrangement whereby the excess power generating capacity of the engine at low loads may be utilized in the generation and storage of both electrical and heat energy."

Conservation of Gas Asked At Goldsmith Hearing

AUSTIN, Tex.—Improper completion of wells was blamed by Shasta Oil Co. as the reason for gas wells in the midst of the Goldsmith field at a hearing held here last week. Shasta seeks to have two gas wells closed in and the gas conserved for use in gas-lifting oil. Owners of one well agreed to have it worked over in an effort to recomplete it as an oil well. Landreth Production Co., owner of the other well, declined to close it in unless some other company will supply gas now furnished to Ector Pipe Line Co. for use in the nearby Harper field. Landreth indicated if its gas contract can be supplied it is willing to attempt corrective measures or close the well if necessary.

Pumping units installed for moving oil from field laterals at Little River, Okla., to the trunk line

Natural Gasoline

Carter Operating Recycling Plant in Southern Illinois

The Carter Oil Co. has established a pressure maintenance system for its producing wells in Fayette County of southern Illinois oil field. Part of the plant is 10 miles north of St. Elmo. The company is drilling its eight wells in each quarter section in a sunflower pattern. In the center of each quarter section as well as at each corner of the quarter section, the company is drilling input wells. Gas from the oil wells is piped to the plant where gasoline is removed. Residue gas is forced back into the input wells to maintain the pressure of the field and boost the ultimate recovery.

Recent Report Shows Decreased Natural Gasoline Production

The production of natural gasoline decreased slightly in September, 1938, according to a report prepared by the Bureau of Mines. The daily average in September was 5,713,000 gallons compared with 5,726,000 gallons in August and 5,981,000 gallons in September, 1937. The largest single decrease occurred in East Texas; this was virtually offset by increases in the Appalachian district, Osage County, Kansas and Louisiana. Production for the nine months of 1938 was 4 per cent higher than for the same period in 1937 (final figures).

SEPTEMBER RECEIPTS AND DELIVERIES BY DISTRICTS

(Thousands of gallons)

	Deliveries		Receipts	
	To refineries	Exports	At refinery-owned bulk plants	By jobbers and retailers
East Coast	.....	.....	24	16
Appalachian	3,354	49	322	1,048
Ind., Ill., Ky., etc.	919	.....	1,471	3,152
Oklahoma	33,503	88	39	1,912
Kans., Mo., etc.	2,556	.....	345	624
Texas Inland	32,082	80	.....	.....
Texas Gulf	6,788	.....	142	3,363
La. and Ark.	5,459	6,587	23	1,340
Rocky Mountain	5,020	.....	28	176
California	52,825	1,512	.....	423
Total	142,506	8,316	2,394	12,054
Daily average	4,750	277	80	402
Total (thous. of barrels)	3,393	198	57	287
Average V.P.	20.1	17.7	17.5	15.2

Stocks increased nearly 6,000,000 gallons reaching 342,678,000 gallons on September 30 compared with 263,676,000 gallons on hand September 30, 1937. In September, 1937, these stocks declined about 32,000,000 gallons.

Shipments to jobbers and retailers were higher than in August but exports declined 39 per cent, or from 13,524,000 gallons in August to 8,316,000 gallons in September. Exports for the nine months of 1938 were 133,140,000 gallons, against 102,438,000 gallons in 1937.

Following the usual seasonal trend, the average vapor pressure of all shipments increased. The weighted average for the month was 19.6 pounds compared with 18.8 in August, and 19.2 pounds in September, 1937.

Repressuring Project Proposed For Turner Valley Field

CALGARY, Alberta.—A report of engineers of Clark Brothers to the Conservation Board of Alberta, outlines a repressuring scheme for the Turner Valley field. The report advises placing three recycling plants in operation, capable of returning about 90,000,000 feet of gas daily to the producing formations. The cost is estimated at $1,837,000 with annual operating costs estimated at $98,987.

The repressuring committee of the Alberta Petroleum Association, headed by Herbert Greenfield, will study the program with engineers of the major oil companies and make a recommendation.

Corpus Christi Plant Nearly Completed

The pressure maintenance plant under construction is nearly completed in the Stratton field in Nueces County, where the Corpus Christi Corp. recently took over the acreage of John F. Camp, of San Antonio.

Refinery Expansion

Addition of Cracking Unit Is Considered by Wyoming Plant

The Bay Petroleum Corp. is reported considering the installation of a Dubbs cracking unit and an Ethyl blending plant at its Cheyenne refinery.

Continental Expands Ponca City Refinery

Plans for a $1,500,000 refinery building program, to install a Cross thermal process cracking unit to increase the gasoline manufacturing capacity at Continental Oil Co.'s Ponca City refinery have been announced by President Dan Moran.

Construction of the new equipment will begin before January 1, and is expected to be completed by August, 1939.

Contract has been let to W. M. Kellogg Co., New York, for approximately $1,250,000 for the erection of the stills, and Continental will spend approximately $250,000 in rearrangement of the steam system and in revising lines, pumping units, electrical systems and other equipment at the refinery.

The new process, which is licensed by Gasoline Products Co., New York, will permit the production of approximately 10 per cent more gasoline from the refinery throughput and will increase the octane rating of the gasoline produced.

Included in the revisions will be the remodeling of certain equipment to permit the continuance of the production of coke at the Ponca City refinery.

In addition to its Ponca City refinery, Continental Oil Co. operates eight other refineries, and the announcement of the building program at the Ponca City refinery follows the completion of a $500,000 expansion program at the company's Denver refinery and other recent construction work at plants located at Artesia, N. Mex., and Baltimore, Md.

Approximately 200 men will be employed in the construction project, one of the largest to be undertaken in the Mid-Continent territory in several years.

New Oil Freight Rates Announced

ALBANY, N. Y.—The New York Public Service Commission has approved new commodity freight rates of the Delaware, Lackawanna & Western Railroad on gasoline, blended gasoline, kerosene, petroleum fuel oil distillates, not suitable for illuminating purposes, in tankcars, estimated weight 6.6 pounds per gallon, minimum weight as per Rule 35 of official classification, from Solvay and Syracuse to Cazenovia, on the Lehigh Valley, 5 cents per hundredweight; reductions effective November 26, 1938.

Of the Delaware, Lackawanna & Western Railroad on the same commodities, same weight classifications, from Syracuse to Oswego, 6 cents per hundredweight, reduction one-half cent per hundredweight. Effective November 26, 1938.

Of the Delaware, Lackawanna & Western Railroad on the same commodities, same weight classification, from Solvay and Syracuse to Lehigh Valley stations, rates in cents per hundredweight: Groton, Locke, and Auburn, 6, reduction 1; Dreyden 6½, reduction one-half cent; Oswego 9, reduction 1; Geneva, Waterloo, Seneca Falls, and Oakwood 10, reduction 1. Effective November 26, 1938.

Of the Erie on the same commodities, same weight classifications, from Wellsville to Medina, on the New York Central, 14 cents per hundredweight, reduction 1 cent per hundredweight. Effective November 27, 1938.

Of the Erie on petroleum, partly refined, upon which further process of refining is necessary, in tankcars, estimated weight 6.6 pounds per gallon, minimum weight as per Rule 35 of official classification, from Irvine Mills and Limestone to Bolivar, on the Pittsburgh, Shawmut & Northern, 9½ cents per hundredweight, reductions. Effective November 27, 1938.

Cracking Units Added to Michigan Refinery

Contracts have been let by the Midwest Refineries, Inc., Alma, Mich., for construction of a new Dubbs reforming and cracking unit for the Alma plant, announces B. J. Skinner, president and general manager. The new unit is expected to be completed and ready for operation by the middle of February. It will have a capacity of 1,200 bbls. per day. Since its inception in Alma in July, 1934, the Midwest company has operated as a skimming plant with a throughput of 3,000 to 3,200 bbls. daily.

PRODUCTION AND STOCKS OF NATURAL GASOLINE

(Thousands of gallons)

	Sept., 1938	Aug., 1938	Jan.-Sept., 1938	Jan.-Sept., 1937	At refineries
East Coast	.....	.....	.....	.....	4,284
Appalachian	4,573	4,094	47,869	51,700	798
Illinois, Michigan, Kentucky	1,028	1,014	9,063	8,700	3,318
Oklahoma	37,621	37,848	351,620	360,900	1,638
Oklahoma City	10,254	10,710	105,968	121,900	.....
Osage County	4,523	4,252	37,210	41,700	.....
Seminole	9,975	10,067	89,481	89,700	.....
Rest of state	12,869	12,819	118,961	107,600	.....
Kansas	4,192	3,865	38,840	41,800	.....
Texas	53,370	58,248	485,712	449,018	9,912
Gulf	6,117	6,653	44,897	27,100	9,114
East Texas	14,618	17,386	141,048	139,400	.....
Panhandle	17,813	18,373	168,756	163,618	.....
North Texas	2,188	2,136	19,024	19,200	.....
West Central	5,506	5,895	51,375	51,600	.....
Rest of state	7,128	7,805	60,612	48,100	.....
Louisiana	7,071	6,760	64,088	77,400	126
Arkansas	2,299	2,378	17,542	8,500	210
Rocky Mountain	6,759	6,845	57,557	54,700	6,258
California	54,489	56,440	496,535	462,600	138,726
Huntington Beach	3,420	3,628	32,017	31,000	.....
Kettleman Hills	15,810	16,204	138,539	137,600	.....
Long Beach	7,875	8,282	69,555	64,300	.....
Santa Fe Springs	5,032	5,226	48,059	47,400	.....
Ventura Avenue	4,517	4,547	41,914	43,800	.....
Rest of state	17,835	18,553	166,451	138,500	.....
Total	171,402	177,492	1,568,826	1,515,318	165,270
Daily average	5,713	5,726	5,747	5,551	.....

Highest Gasoline Yield in September Since 1935

A material decline in crude oil production was recorded in September, when the daily average was 3,288,700 bbls., or 136,000 bbls. below the level in August and about 380,000 bbls. under the average of September, 1937. The decline in production in September was primarily in Texas, which had both Saturday and Sunday shutdowns, compared with just Sunday shutdowns in August.

In spite of the material decline in production, the September crude stock reduction of about 3,500,000 bbls. was hardly more than in August. This was due mainly to a material decline in exports.

Primarily because of heavy reruns, but partly because of declines in production of most of the minor products, the yields of gasoline, gas oil and distillates, and residual fuel oil all increased over August. The gasoline yield was 45.3 per cent, the highest since July, 1935.

As generally expected, the domestic demand for motor fuel for September was disappointing, being only 46,058,000 bbls., compared with 47,515,000 bbls. (final figures) for September, 1937. The primary factor in this decline was the poor weather in some important consuming areas. On the other hand, the generally fair weather and business upturn of October should compensate September's deficiency in demand. Exports of gasoline declined sharply, the total being 3,528,000 bbls., compared with 4,829,000 bbls. in August and 4,456,000 bbls. in September, 1937. Here again, indications point to a reaction in October. The high yield and low demand led to a subnormal reduction in gasoline stocks, the total for finished and unfinished on September 30 of 69,086,000 bbls. being only about 1,900,000 bbls. below stocks the first of the month and about 3,700,000 bbls. above the level in 1937.

The September statistics for the other refined products were not particularly encouraging, demand for the fuel oils continuing to run under a year ago. A bright feature was in the apparent strong demand for industrial lubricants.

United States Supply and Demand—Crude Oil (Bbls.)

First nine months 1938 and 1937

9 MONTHS—	TOTAL SUPPLY	TOTAL DEMAND	EXCESS DEMAND	EXCESS PCT.	DOMESTIC PRODUCTION	IMPORTS	INDICATED DOMESTIC DEMAND‡	EXPORTS	STOCKS REFINABLE CRUDE SEPT. 30
1938	929,070,000	989,547,000	60,477,000	6.5	910,570,000	18,500,000	929,540,000	60,007,000	‖282,136,000
Daily average	3,403,000	3,624,000	.....	...	3,335,000	68,000	3,405,000	220,000	.....
1937	977,065,000	984,755,000	7,690,000	0.8	956,833,000	20,232,000	935,922,000	48,833,000	310,271,000
Daily average	3,580,000	3,607,000	.....	...	3,505,000	74,000	3,428,000	180,000	.....
Increase, 1938	†47,995,000	4,792,000	.....	....	†46,263,000	†1,732,000	†6,382,000	11,174,000	†28,135,000
	†5.2%	4.9%	.....	....	†5.1%	†9.3%	†0.7%	23.0%	†10.0%

Supply and Demand—Refinery Products—Motor Fuels (Bbls.)

9 MONTHS—	TOTAL SUPPLY	TOTAL DEMAND	EXCESS DEMAND	EXCESS PCT.	DOMESTIC PRODUCTION	IMPORTS	DOMESTIC DEMAND	EXPORTS	STOCKS SEPT. 30§
1938	421,968,000	425,296,000	3,328,000	0.8	421,889,000	79,000	388,745,000	36,551,000	71,322,000
Daily average	1,545,000	1,558,000	.....	...	1,545,000	290	1,424,000	134,000	.....
1937	424,326,000	420,448,000	*3,878,000	*0.9	424,267,000	59,000	391,723,000	28,725,000	64,315,000
Daily average	1,554,000	1,540,000	.....	....	1,554,000	215	1,434,000	105,000	.....
Increase, 1938	†2,358,000	4,848,000	.....	....	†2,378,000	20,000	†2,978,000	7,826,000	7,007,000
	†0.6%	1.1%	.....	....	†0.6%	34.0%	†0.8%	27.2%	10.9%
Kerosene									
1938	48,102,000	44,688,000	*3,414,000	*7.6	48,102,000	.....	38,985,000	5,703,000	10,497,000
1937	47,892,000	44,686,000	*3,206,000	*7.2	47,892,000	.....	37,862,000	6,824,000	8,839,000
Increase, 1938	210,000	2.000	208,000	....	210,000	.....	1,123,000	†1,121,000	1,658,000
	0.4%	.....	6.5%	....	0.4%	.....	3.0%	†19.7%	19.0%
Gas Oil and Residual Fuel Oil¶									
1938	347,042,000	325,648,000	*21,394,000	*6.5	331,003,000	16,039,000	288,923,000	36,725,000	133,691,000
1937	354,241,000	357,984,000	3,743,000	1.1	336,257,000	17,984,000	324,194,000	33,790,000	116,027,000
Increase, 1938	†7,199,000	†32,336,000	.....	....	†5,254,000	†1,945,000	†35,271,000	2,935,000	17,664,000
	†2.1%	†9.9%	.....	....	†1.6%	†12.1%	†12.2%	8.7%	15.2%
Gas Oil and Distillate Fuels									
1938	111,288,000	102,994,000	*8,294,000	*8.0	111,288,000	.....	79,347,000	23,647,000	30,860,000
1937	106,359,000	102,152,000	*4,207,000	*4.1	106,343,000	16,000	79,435,000	22,717,000	27,020,000
Increase, 1938	4,929,000	842.000	.....	....	4,945,000	.....	†88,000	930,000	3,840,000
	4.6%	0.8%	.....	....	4.6%	.....	†0.1%	4.1%	14.2%
Residual Fuel Oils									
1938	235,754,000	222,654,000	*13,100,000	*6.0	219,715,000	16,039,000	209,576,000	13,078,000	102,831,000
1937	247,882,000	255,832,000	7,950,000	3.2	229,914,000	17,968,000	244,759,000	11,073,000	89,007,000
Increase, 1938	†12,128,000	†33,178,000	.....	....	†10,199,000	†1,929,000	†35,183,000	2,005,000	13,824,000
	†5.1%	†14.9%	.....	....	†4.7%	†12.0%	†16.7%	18.1%	15.5%
Lubricating Oils									
1938	23,275,000	23,186,000	*89,000	*0.4	23,275,000	.....	15,877,000	7,309,000	7,605,000
1937	26,217,000	26,162,000	*55,000	*0.2	26,217,000	.....	17,763,000	8,399,000	6,542,000
Increase, 1938	†2,942,000	†2,976,000	.....	...	†2,942,000	.....	†1,886,000	†1,090,000	1,063,000
	†12.6%	†12.8%	.....	....	†12.6%	.....	†11.9%	†14.9%	16.2%
Petroleum Wax (Lbs.)									
1938	346,007,000	361,981,000	15,974,000	4.6	319,760,000	26,247,000	220,969,000	141,012,000	129,018,000
1937	412,298,000	404,169,000	*8,129,000	*0.2	385,280,000	27,018,000	229,880,000	174,289,000	123,563,000
Increase, 1938	†66,291,000	†42,488,000	.....	....	†65,520,000	†771,000	†8,911,000	†33,277,000	5,455,000
	†19.1%	†11.7%	.....	....	†25.0%	†3.0%	†4.3%	†24.0%	4.4%

*Excess supply. †Decrease. ‡Crude oil only. §Includes finished and unfinished refinery gasoline and natural gasolines. ¶Gas oil and fuel oil equals gas oil and distillate fuels plus residual fuel oils. Note: Total supply equals domestic production plus imports. Total demand equals domestic demand plus exports. Data on demand for refined products are based on refinery shipments. ‖Does not include 17,535,000 bbls. of heavy oil in California. Comparable figure for Sept. 30, 1937, not available.

Crude Oil Run to Stills and Total All Oils (Bbls.)

9 MONTHS—	TOTAL IMPORTS§	TOTAL EXPORTS§	TOTAL CRUDE TO STILLS	PER CENT YIELD GASOLINE‡	NATURAL GASOLINE PRODUCTION	TOTAL SUPPLY ALL OILS*	TOTAL DEMAND ALL OILS*	STOCKS ALL OILS SEPT. 30*
1938	39,318,000	147,554,000	868,955,000	49.7	37,353,000	988,404,000	976,436,000	575,954,000
Daily average	144,000	540,000	3,193,000	...	137,000	3,620,000	3,577,000	.....
1937	43,858,000	128,129,000	880,439,000	48.1	36,079,000	1,039,002,000	997,689,000	560,542,000
Daily average	160,000	469,000	3,225,000	...	132,000	3,806,000	3,655,000	.....
Increase, 1938	†4,540,000	19,425,000	†11,484,000	...	1,274,000	†50,598,000	†21,253,000	15,412,000
	†11.6%	15.2%	†1.3%	...	3.5%	†5.1%	†2.2%	2.7%

*Total all oils includes crude and refined products, natural gasoline and benzol. Stocks on Sept. 30, 1938, represented 161 days' supply which compared to 153 days on same date in 1937. †Decrease. ‡Includes natural gasoline blended at refineries. §Includes crude oil and refinery products. In case of imports includes receipts in bond and for domestic use. All data based on Bureau of Mines reports.

INTERNATIONAL NEWS

Mexican Problem Occupies Courts and Diplomats

Oil companies ousted from Mexico continued their struggle last week to recover their properties valued at $400,000,000 to $450,000,000 through Mexican legal channels. Probably the most significant development in the negotiations between the United States and Mexico, however, was a settlement of the agrarian land expropriation issue. Mexico has devised a means of paying for approximately $10,000,000 worth of agrarian lands expropriated from United States citizens over the past 10 years. The plan was expected to involve the monthly deposit of stipulated amounts until the entire sum has been liquidated.

The impression has been permitted circulation in the United States for several months that settlement of the agrarian land expropriation issue was essential before the State Department could gracefully tackle the oil problem. Furthermore, with a comparatively small sum involved in the agrarian land dispute, it has been held probable a precedent might be set through these negotiations which would be helpful in considering the petroleum property matter. In short, the U. S. Government may now find itself in the position of demanding return of oil properties seized March 18, 1938, unless the Mexican Government can show acceptable ability to pay claims of the individual corporations involved. In the case of the agrarian land, the Mexican Government can apply proceeds from silver sales to this country and other income toward a comparatively small debt, but it would be an entirely different matter to liquidate a bill of $400,000,000 in a similar manner.

Robert L. Cantu, chief engineer for one of the Standard Oil Co. of New Jersey subsidiaries in Mexico, was ordered off approximately 1,500 square miles of nonexpropriated holdings last week. Mexican Government functionaries were reported making an inventory and it was said that Mr. Cantu's automobiles and the drilling equipment over which he had supervision had been seized. However, no formal expropriation order had been issued. The company immediately petitioned a court in Mexico City to limit government officials' activities to inventorying, alleging before the court that this is the usual preface to expropriation.

In another gesture, the 17 American and British oil companies filed a three-point suit in the second federal District Court in Mexico City. The action challenged constitutionality of the November, 1936, expropriation law, the executive decree seizing oil holdings, and President Cardenas' decision October 25, 1938, rejecting the companies' joint "administrative appeal" against loss of their properties. A similar suit, pending for several months, was dismissed by the Supreme Court on October 8 on the ground that there was no room for appeal against constitutionality of the expropriations until a ruling was handed down on the companies' "administrative appeal." With the latter decided against the firms, the way was cleared for filing the latest suit. Judge Manuel Batlett set March 17 1939, as the date for hearing the suit, lacking one day of being the first anniversary of the seizure.

In an interview at Mexico City, President Cardenas said Mexico's debt to foreign oil companies will be paid in 10 years. He continued that funds are now being set aside in unnamed depositories for liquidation of the debt, but did not amplify these remarks to disclose how much money has or will be accumulated for this purpose.

Shipments of Mexican crude oil to the Gulf Coast of Texas where Eastern States Petroleum Co. is processing it under bond were reported to be increasing and the daily average receipts were reported now to run approximately 14,000 bbls.

The Netherlands Government entered the oil property confiscation controversy last week with a strongly worded diplomatic message demanding immediate payment for the seized holdings of the Royal Dutch-Shell subsidiaries or return to their owners. The demand, which called attention to the fact that six months have passed since the oil expropriation without action toward the payment of indemnities by Mexico, is the culmination of a series of notes on the oil seizure. Previous notes, which were not made public, had been delivered by The Hague on March 15, April 4 and July 29.

Secretary of State Cordell Hull has not made public any of the United States notes regarding oil, but in two notes to Mexico on the matter of indemnities for expropriated agrarian land he asserted that prompt, immediate, effective payment for private property seized is a basic principle of international law.

The note from the Netherlands Government is held in diplomatic circles to raise the issue clearly of whether the United States can deal unilaterally with Mexico on the expropriation problem when the Monroe Doctrine in practice makes it impossible for European governments to bring action in order to protect their investments in the Western Hemisphere.

The Netherlands note said in part:

"The government of The Netherlands maintains that even in cases where circumstances oblige a government to expropriate private property, it is a condition sine qua non that the properties expropriated must be exactly defined . . . and that just and prompt indemnity shall be immediately and effectively guaranteed.

"In the attitude of the Mexican Government after the decree of expropriation, the Netherlands Government cannot do less than see a refusal to acknowledge these fundamental rules. Six months have passed since the day of expropriation and the properties expropriated have not yet even been defined.

"Therefore, the government of the Low Countries feels obliged to express new hope for a satisfactory arrangement of this controversy, an arrangement that cannot consist in less than adequate, prompt and effective compensation or in return of the properties expropriated to the companies affected."

Similarity of the Netherlands stand on indemnity to that previously expressed by Secretary Hull has added much weight to this attitude and is expected to be the basis for final negotiations when they are brought to a head.

Venezuela October Output Was Above September

Estimated crude oil production in Venezuela last month increased to 17,113,800 bbls., a daily average of 552,058 bbls. The figures compare with a total of 16,172,363 bbls. and daily average of 539,080 bbls. reported for September.

Despite the increase registered in October, crude production from Venezuela remains below the rate for 1937. In October last year the country produced 17,547,297 bbls., or at the daily average rate of 566,042 bbls.

A change in the method of reporting production by Lago Petroleum Corp. for October prevents a comparison of current output from Lagunillas, La Rosa, and Tia Juana with the rate existing in 1937. Lago production for all Lake Maracaibo fields was grouped last month and arbitrarily assigned to Lagunillas in the following table. More than 1,000,000 bbls., possibly 2,000,000 bbls. of the Lagunillas total of 9,055,534 bbls. shown for last month in the table rightfully belongs to La Rosa and Tia Juana where Lago is among the large producers. Lacking detailed information, an estimate of 40,000 bbls. was assigned Mene Grande Oil Co. production in the Temblador field in the eastern part of the country.

Lapaz, Tia Juana, Tarra, Cumarebo, and Pedernales are the fields maintaining yield this year at a higher rate than prevailed in 1937. In addition, there are Temblador and Bachaquero, the latter south of Tia Juana in the Lake Maracaibo district, which did not appear in production reports for the comparable period in 1937. Substantial declines have been suffered by Lagunillas, Mene Grande, and Quiriquire fields.

Current production from all Lake Maracaibo fields totaled 12,861,164 bbls. last month compared to 13,144,372 bbls. for the same month a year ago. This comparison is more nearly representative of the present status of lake fields than figures for the individual pools in the following table:

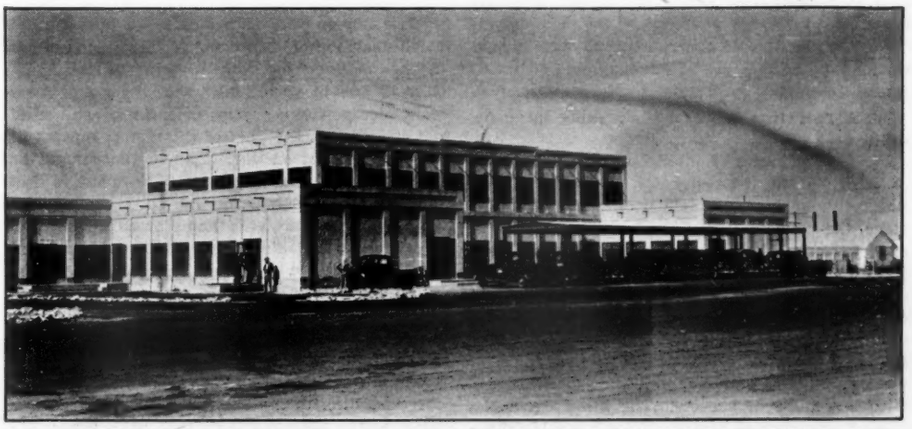
VENEZUELA CRUDE PRODUCTION

(By Fields)

	Oct., 1938	Oct., 1937	Dly. avg. Oct., 1938
Lagunillas*	9,055,534	8,252,101	292,114
La Rosa	999,608	2,251,256	32,245
Tia Juana	2,728,874	2,641,015	88,028
Quiriquire	2,025,193	2,246,152	65,329
Mene Grande	973,937	1,244,994	31,417
Tarra	491,461	386,168	15,854
Temblador	224,578	..	7,245
Cumarebo	208,885	198,545	6,737
Pedernales	141,997	131,215	4,581
Lapaz	58,985	51,503	1,903
Concepcion	75,024	87,835	2,420
El Mene	52,576	56,513	1,696
Bachaquero	77,148	.....	2,489
Total	17,113,800	17,547,297	552,058
Daily average Oct., 1937		566,042	
Total Sept. 1938		16,172,323	
Daily average Sept., 1938		539,080	

(By Companies)

Venezuela Oil Con.	5,899,586	5,232,444	190,309
Lago Pet. Corp.	4,887,980	5,570,794	157,677
Std. of Venezuela	2,713,039	2,944,748	87,517
Mene Grande Oil Co.	2,043,000	2,062,000	65,903
Caribbean Pet. Co.	973,937	1,244,994	31,418
Colon Dev. Co.	491,461	386,168	15,854
British Controlled	52,576	56,513	1,696
No. Venez. Pet.	52,221	49,636	1,684
Total	17,113,800	17,547,297	552,058



Main office building of Bahrein Petroleum Co., Bahrein Island

THE VALUE OF SOIL-SURVEY METHODS

By J. M. Pearson
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Within the latitude permitted by the above title there are so many points of view, and so many diverse data supporting each view, that the following may appear to some to be quite beside the point. The writer has drawn freely upon the works of many whose names appear in the bibliography. He wishes to express his gratitude to those who very kindly permitted the use of confidential material for this paper. The bibliography contains several titles of confidential papers, material from which was not included herein, but which papers contain pertinent discussions of value to pipe-line corrosion technologists.

Soil-survey methods are valuable to pipe-line technologists because their use may lead to:

1. A reduction of long-time over-all operating costs.

2. A reduction of the rate of physical depreciation, and an increase in salvage value of buried lines.

3. A reduction of hazards entailing large liabilities.

4. A satisfaction of intellectual curiosity.

Item (4) and the restriction of "value to pipe-line technologists" are mentioned because, at this stage, the valuable use of present methods can be expected only from those familiar with the complexities, pitfalls, and extreme limitations they must recognize; the satisfaction of the intellectual curiosity of those engaged in this work is the only road to more reliable methods. It is safe to say at the beginning that there are no rules of procedure that can be followed mechanically with any hope of success. The blind extrapolation of empirical or statistical formulas leads nowhere, if not to obvious absurdities.

In the following ideas, corrosion technologists will recognize many old friends; technologists not primarily interested in corrosion will have a glimpse of the methods of attack, and of the great amount of study and progress made by those engaged in the work. While we cannot hope to evaluate all soil-testing methods, we shall try to illustrate how such evaluations can be made. It is hoped that some of the lines of attack will prove interesting enough to encourage more people to make appropriate studies.

The Mechanism of Corrosion and Its Relation to Soil Tests

Perhaps the best way to view present soil-survey methods is from the standpoint of the mechanism of corrosion. From this viewpoint the rationality of a given method can be appraised. The final test of usefulness must be whether the chosen method gives predictions in substantial agreement with experience.

A. Fundamental reactions.

We may consider it an established fact that corrosion is fundamentally an electrochemical process.[1,2,3] The basic reaction:

$$Fe + 2H^+ \rightleftarrows Fe^{++} + 2H$$

This says that hydrogen ions tend to give up their charge to iron atoms, producing iron ions and nascent hydrogen. In stray-current electrolysis the iron undergoes an exactly similar change, except that the impressed current furnishes the charge for the iron ions.

There are two selected equilibria represented in this relation:

$$Fe \rightleftarrows Fe^{++} + 2e^-$$
$$H \rightleftarrows H^+ + e^-$$

The tendency of these reactions to proceed can be expressed in terms of a potential which depends upon the ion concentration and temperature, and in the case of gases on the gas pressure. The relations involved are well known from measurements and thermodynamic considerations, and are beautifully set forth in the paper by Burns and Haring.[3] It is sufficient to note here that the familiar rules of chemical reactions apply to the above ionic equilibria, viz., that an increase in the quantities on one side of the equation drives the reaction in the direction of the other side. The higher the concentration of positive ions, the more positive is the potential of the electrode in equilibrium with them.

B. Polarization phenomena and aeration.

The tendency of iron ions to go into solution at the surface of any commercial pipe varies in marked degree from point to point on its surface. This is due to variations in scale or slag inclusions, composition, crystal orientation, and residual stresses, on the part of the metal; but is still more dependent on variations in the contact between the soil and the iron. The result is that instantly upon immersion in (soil) water, there are formed numerous cathodic areas upon which hydrogen ions discharge, and corresponding anodic areas at which iron ions go into solution. The reduction of hydrogen-ion concentration adjacent the cathodic areas and the increase in metal ion concentration at the anodes very rapidly reach an equilibrium represented by an approximate equality in the electromotive forces corresponding to the above ionic reactions. In as much as the ionic reactions take place separately, an electric current flows through the metal from the cathodic areas to the anodes, and back through the soil.

All would be well, and corrosion would cease, if both the anodic and cathodic areas reached identical potentials, or if the electrical circuit were interrupted. Anything that upsets the equilibrium increases the tendency to corrode. Precipitation of the iron ions as insoluble salts at the anodes, or removal of the hydrogen film at the cathodes, can separately or collectively promote corrosion. In the great majority of cases of soil corrosion, the depolarization of the cathodes is the controlling factor. The most common depolarizing agent is dissolved oxygen. However, hydrogen can be removed from cathodic areas in several other ways—which are, in rough order of importance:

1. Mechanically, by agitation.

2. By bubbling off.

3. By entering into the metabolism of anaerobic bacteria.

C. Corrosion processes of acid soils.

Let us now try to visualize the corrosion of a pipe line as it runs the gamut of soils. We must bear in mind the picture of separate anodic and cathodic areas, the factors tending to destroy electrical equilibrium, and the counteracting effects. The part played by the soil as a more or less poor electrical conductor, and its texture, affect the earth return circuits.

Suppose the line is in a soil having a strong acid reaction (pH* 3 to 4.5). Under these conditions the tendency of the iron to go into solution at the anodes is so strong that the hydrogen liberated at the cathodes may reach atmospheric pressure and bubble off. The chief corrosion-limiting factors in the condition are a depletion of the acid by the pipe, and formation of insoluble salts of iron which tend to shield the pipe. If the soil is buffered, or if it is porous enough so that ground water can circulate, the supply of acid is renewed and the corrosion proceeds rapidly. If the products of corrosion are soluble or adhere loosely, they are less protective. Due to the rapid removal of the pipe surface, the anodic and cathodic areas are continually shifting—with the result of a general attack over the whole pipe surface. The presence of oxygen to combine with the hydrogen at the pipe surface further enhances the rapidity of the attack; a large excess of oxygen in well-drained acid soils may, on the other hand, seal off the anodes by precipitating iron salts—with a corresponding reduction of the corrosion rate. In as much as the paths of the corrosion currents through the soil are very short, the resistance of the soil is of little importance.

D. Corrosion processes in intermediate soils.

In soils whose waters are less acid or slightly akaline (pH 5.5 to 7.5) the equilibrium of the sur-

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face film of nascent hydrogen and the hydrogen dissolved in the metal with the hydrogen ions determine the rate of corrosion. The principal agent effective in disturbing the equilibrium is oxygen. In mildly-aerated soils, the hydrogen film is slowly removed—and more hydrogen is formed at the cathodes at the expense of the iron at the comparatively small anodes. The result is pitting, and the secondary limiting factor is the precipitation of the less-soluble ferric compounds (ferric hydroxide) at the pit mouths. If the soil water has dissolved chlorides, nitrates or sulfates, the resulting compounds are more soluble and less protect-

*Hydrogen-ion concentration.

ing. Silicates and carbonates, in the more alkaline soils, from very tough protective coatings.

The texture of these soils has a marked influence, other things being equal. The exclusion of oxygen at the contact of a soil clod with the line can produce an anode, with pitting. In finer textures, the number of anodes is increased, and the cathode area correspondingly decreased—with resulting slower and more uniform corrosion. Rogers[5] has suggested that loose backfills might be responsible in part for the high initial pitting rate.

As more and more oxygen gains access to the buried line, the cathodic areas grow, and the pitting intensifies as the anodic areas decrease. The anodic polarization becomes the limiting factor, and the half-cell potential of the line as a whole becomes more electropositive. When a great excess of oxygen is available, the hydrogen film may be entirely removed, and a new equilibrium established. An oxygen-concentration cell may form, the gas dissolving probably in a thin oxide film formed on the metal, and the cell potential being determined by the electrode oxygen pressure and the concentration of hydroxyl ions. As the latter are negative, an increase in their number lowers the potential of the electrode, contrary to the effect with the hydrogen electrode of an increase in hydrogen ions. An excess of oxygen of this magnitude tends also to oxidize and precipitate the ferrous ions at the remaining adjacent anodes, clear down to the base metal. At pit mouths, the anodic currents are reduced by precipitation of the less-soluble ferric hydroxide. It is possible, then, that a whole section of the line may become cathodic to an adjacent section of the line that is less well-aerated. The comparatively large geographical displacement of the anodic and cathodic reactions is then observable in long-line currents. At the same time, the resistivity of the soil becomes more important as a control of the rate of corrosion. In as much as current densities are higher at the anodes (the anodic areas being smaller), the resistivities adjacent the anodes are more pertinent. It is noteworthy that the same factors that reduce the aeration within a soil tend also to promote a lower resistivity.

The cathodic part of the line may remain passive for some time after the excess of oxygen has been removed. The presence of chlorides especially, and sulfates or nitrates, tends to destroy this passivity and to start local pitting again. The variation of long-line currents with rainfall, for example, is a familiar experience.

E. Corrosion processes in alkaline soils.

In alkaline soils (pH 7.0 to 9.5) the net half-cell potential of a pipe line tends to become more electropositive. In the anodic areas, the reduced solubility of the ferrous hydroxide causes it to form a more gelatinous and protective layer. The increased solubility in soil water of the silicates and carbonates makes these radicals available for precipitation of hard protective coats. Anodic polarization becomes the corrosion-limiting factor.

The presence of large amounts of dissolved salts whose anions form soluble salts of iron (—Cl, —SO_4, —NO_3, etc.) prevent the formation of insoluble protective layers. Under these conditions the increased number of ferrous ions in solution at the anodes tends to reduce the anodic polarization, and the half-cell potential of the line becomes correspondingly more electronegative. These salts are, therefore, one of the important factors in alkaline soils in the determination of the corrosion rate, as they are in other soils.

At the cathodic areas, the half-cell potential is increased as before by the presence of oxygen. Due to the smaller amounts of hydrogen at these points oxygen, in lower concentrations, can passivate the surface and create extensive sections that are almost entirely cathodic. The resulting long-line currents are found to be a more reliable means to locate corroding areas, and the inverse correlation of corrosion and soil resistivity becomes better.

Practical Soil Testing

Before choosing the method to be used in making a soil survey, a pipe-line technologist must determine the use to which the information is to be put. If he wants to reduce the occurrence of leaks, avoid reconditioning expense, and reduce hazards, he must try to deduce the behavior of a soil in regard to pitting. An accurate knowledge of weight loss would be of little use. If he wants to reduce over-all long-time operating costs, he should try to predict the reconditioning program, and determine if and where the present cost of protection is justified. The distribution and rate of corrosion are most pertinent to this problem.

A. Consideration of ultimate purpose in making soil tests.

The "corrosiveness" of a soil is rather hard to define. Pipeliners are likely to look at it from the standpoint of the number of leaks that need fixing. The pipe-wall thickness, then, illogically becomes a part of the corrosion picture; and soils that would not be corrosive to thick pipe because of gradual cessation of active corrosion would be corrosive for thinner pipe. In that which follows we shall develop one definition of corrosiveness that is entirely related to the soil.

An ideal survey should yield data from which the progress and type of corrosion reasonably can be predicted, so that the choice both of pipe-wall and protective measure can be determined economically. Future savings are the only justification for making the survey.

B. Soil tests examined in light of corrosion experience.

The best possible criterion of the value of a given method of survey is whether its predictions agree with experience.

1. *The statistical nature of corrosion data.*—When we examine experience for suitable criteria of corrosiveness, we are confronted with the highly statistical nature of the data. Two adjacent joints of corroded pipe in substantially the same soil can show extreme differences in corrosion. It becomes apparent that corrosion data from pipe lines in any one soil can be reduced to consistency only by taking averages over great lengths of pipe; and criteria of "corrosiveness" are available only in terms of the probable number of leaks per 1,000 feet, or mean depth of maximum pit per unit length, or the average loss of weight per square foot, as a function of time. We do not possess the multitude of careful measurements and statistical analyses needed to reduce corrosion experience to the exactness of actuarial data. Many very able analysts have made substantial inroads into existing data, emerging with several interesting relationships. Ewing[1,2,9]; Martin[3]; Rhodes[4]; Evans[7]; Logan. Ewing, and Denison[17]; Logan,[10] and many others are gradually producing order out of chaos in corrosion measurements. Reference 13 contains a good modern bibliography.

In order to illustrate the interpretation and use of data taken from corrosion measurements, we shall use one of several possible approaches.

a. Suppose we have a leak history from an old pipe line, and know the distribution of the corrosion experience in each type of soil. Suppose we have measured the depths of the first hundred deepest pits on each joint of corroded pipe.

If we use log-log graph paper and plot the total number of corrosion leaks in each soil as a function of the age of the line, we obtain a substantially straight line for the earlier part of the data. The lines thus plotted tend to break and follow a different slope, usually at about the time the corrosion process was disturbed by reconditioning or by preventive measures.

The approximate time of occurrence of the first leak is the time at which the line crosses the log-time axis.

This is a good beginning, but the curve is of little use for predicting what a new line will do in the same soil. If the new line were half as long, we should expect the total number of leaks at a given time to be fewer. If the new line has a thinner wall, the expected corrosion corresponding to some of the deeper pits in the old line will represent punctures in the new line. This would increase the number of failures on the new line at any time. It becomes evident that we must find from the data how the probable depth of the deeper pits depends upon the exposed pipe area, and also how pitting progresses with time. G. N. Scott[12] has approached this problem, and has deduced a "pit-depth area" relation: If we take the average depth of the deepest pits on each of our joints of pipe, and let the area of one joint be the unit of area, we have two correlated values. If we do the same for two successive joints considered as one, we shall obviously obtain a greater average value of the deepest pit associated with an area of two units. As we increase the number of joints in each grouping, we get larger values of the average deepest pit—until the final group includes all the joints, and the single deepest pit of all. If we plot the set of data thus obtained on log-log paper (in effect the logarithm of the average depth of the deepest pit against the logarithm of the area associated with it) we again obtain a substantially straight line.

While we have taken Scott's relation for the purpose of this illustration, it would be well to call attention here to the shortcomings of the method of analysis. The problem of pit distribution is still a moot question. The following comments are made in the hope that operators will become interested, if not in the analysis, in taking careful measurements of the corrosion found on old lines. Such data should include pit-depth measurements of, say, the first hundred deepest pits on each joint of pipe in each type of soil. If a larger number of shorter units of length is used, correspondingly fewer of the deeper pits per unit could be recorded. These data—with pipe size, age, and the type of soil causing corrosion—will yield eventually better information on the statistical distribution of pits.

The most obvious objection to the calculations made to plot Scott's relation is that there is no *a priori* reason for grouping the original unit areas as they come rather than in any of several other possible orders. Ewing[2] has shown how the data may be treated to obtain the best average from all possible groupings; when this has been accomplished, the graphs on log-log paper are smooth curves, but usually not straight. He derives a semi-log relation that produces a somewhat better set of curves. While all the lines are not straight, the number that curve one way are about equal to the number curving the other. In general, the relation:

$$P = P_1 (C \log A + 1)$$

Where:

P_1 = average depth of deepest pits on all unit areas.

C = constant.

provides a generally good fit to the calculated data.

A method of treatment proposed by Rhodes[4] uses the average depth of the deepest pits on all 1-foot lengths as 100 per cent on a linear ordinate scale showing "per cent depth of pit." Against this is plotted, on a logarithmic scale, the average *number* of pits per foot whose per cent depths are equal to or greater than each corresponding

ordinate. The result obtained by this method, using 30,000 pit measurements, shows remarkable consistency between data plotted for averages from 18-inch samples and averages from whole pipe joints.

While it is not the province of this paper to propose a definite procedure in arriving at a pit-depth area or pit-depth time relation, it is desirable to point out that a satisfactory explicit relationship must be found in order to evaluate "corrosion experience" in terms of tangible quantities. It is hoped sincerely that pipe line technologists interested in corrosion will study this problem, and accumulate the necessary data for its solution.

Returning now to Scott's relation which we were using to illustrate interpretation of corrosion data, we can translate the graph obtained into words. It says that the average depth P of the deepest pits on a number of areas A units big will be $P = P_1A^a$: *where* P_1 is the average depth of the deepest pits on many unit areas; and a is the slope of our graph.

b. It is noted that $P = P_1A^a$ says nothing about time. The relation was derived from many samples of the same age. The exponential nature of the relation of pit depth with time is given by the leak-time curve, so that by combining we have:

$$P = kA^aT^n$$

Where:

P = average depth of deepest pit on many areas A units big after T units of time.
k = mean depth of all deepest pits on all unit areas at unit time.
A = total area in terms of unit areas.
a = exponnent in Scott's equation.
T = age of line expressed in units chosen.
n = slope of corrosion-time curve.

This equation contains all the elements needed to describe quantitatively the corrosion behavior of a pipe of any wall thickness in any soil *if* the constants are known accurately. Anyone attempting to base predictions upon it should know the amount of uncertainty in each constant, and should criticise his prediction by determining the range through which it might vary because of these uncertainties.

The value of k can be defined conveniently as the corrosivity of the soil; n has been found to correlate inversely with the aeration of the soil; a varies between different soils, but so far has not correlated with any one property; k, n, and a thus describe the corrosion behavior of a soil, independently of pipe-wall thickness. Incidentally, the slope of the leak-time curve is $-\frac{n}{a}$ in terms of these constants, so that one must be known to determine the other from the leak history.

If we had such a large amount of measured corrosion experience that the value of these numbers were determined accurately for each soil and the accuracy of the relation were proved sufficient, we should have the tool with which to predict the corrosion losses to be expected on any substantially long stretch of line in any one soil. A soil survey would then consist chiefly in identifying the soils.

However, we do not yet have these constants within anything corresponding to good engineering limits, and for many conditions they are not determined.

c. A simple analysis of the errors possible shows that the per cent uncertainty in the value of P is:

$$\frac{\delta P}{P} = \pm \sqrt{[2.3\delta a \log_{10} A]^2 + [2.3\delta n \log_{10} T]^2 + \left[\frac{\delta k}{k}\right]^2}$$

Where:

δa, δn, and δk are the uncertainties in the actual values of a, n, and k. Obviously, if we try to predict P for areas much larger than the units used, or for times much longer than the time of our experience, the result rapidly will become useless. A sample of the calculation of these errors from a set of corrosion data is given by Logan[16] in a confidential paper.

d. Lacking accurate values of the "soil constants" for many soils, several investigators have tried to devise short-time tests, the results of which can be translated into these constants. Eminent among these are Denison,[16] and Logan, Ewing, and Denison.[17] The method used by these men is to construct an electrolytic cell in which soil is the electrolyte. The water content and packing of the soil carefully is controlled. The anode is a steel disc separated a short distance from the cathode, and the latter is arranged to be aerated by oxygen that diffuses through a layer of the soil. It is thus that most of the important elements of corrosion are represented in the cell. It is found that after short-circuit for a suitable time the weight loss and pitting of the anode, on the average, will correlate well with similar quantities found by burying specimens in the soil tested. If they measure the cell potential as related to current density and determine from a graph the mean current density between 0 and 0.3 volt, they find a correlation between the mean current density and corrosivity k expressed by:

$$P = 4.2\ I + 52$$

where: P = average depth of deepest pits in mils on 1 square foot of buried sample after 12 years. In this equation, $P = k$, if the unit of area is 1 square foot and the unit of time is 12 years:

I = average current density, in milliamperes per square decimeter, in the corrosion cell, between 0 and 0.3 volts.

The standard error in the correlation of P is $\pm$ 26 mils. Perhaps the best values to date of the soil constants are given by Logan, Ewing, and Denison in this paper.[17]

It is thus seen that the value of soil tests of this nature is steadily increasing, and that interpretation of data from experience is becoming more exact and usable. The pipe-line technologist should, at the present time, make sure that he understands the definitions, reasoning, and experimental limitations back of any "corrosion formula" he wishes to use. Only under these conditions can he see where he may expect a good enough batting average to make his soil survey of real value.

2. Empirical evaluation of soil tests.

In the evaluation of soil-survey methods, it is axiomatically true that hindsight is better than foresight. Ewing[9] and Denison and Ewing[15] make use of this principle. The investigator examines the corrosion experience, such as leak repairs made in each soil after a given lapse of time, or such as the per cent of line reconditioned or replaced in each soil at a given time, etc., in relation to soil-survey methods. The procedure followed by the investigator is to approach the data, as it were, from the back door and ask himself: "Suppose at the beginning I had applied criterion x to determine where corrosion protection was needed, how much would I have saved in operating costs at the present time if the protection was y per cent effective?" For instance, if he had decided to coat all line pipe in soil of resistivity less than 1,000 ohm centimeters, and the coating would have saved 75 per cent of the replacement costs where applied, he can calculate from soil-survey data the amount of line that would have been coated, the location of coatings, the saving in repairs, and the cost of coating. By repeating this process he finds out, for each value of resistivity used as a criterion:

1. How much the use of each value of resistivity used as corrosion criterion actually would have saved.
2. How well the indicated location of coatings corresponds to "hot spots."
3. How much coating is wasted.

He can repeat the process for another criterion such as total acidity, correlating any desired data from experience with different values of acidity. He can correlate, instead of costs, any other determinable item in corrosion: such as per cent of pipe replacement in 20 years, or average number of punctures per 1,000 feet with one or a combination of soil properties that can be measured such as pH, total acidity, resistivity at saturation, salt content, depolarizing effect of the soil in a test cell, etc. The use of this line of attack is to be recommended as a valuable means of arriving at the most useful type of soil survey to make.

Ewing[9] shows the application of this method in acid soils. He finds that the correlation between hot spots and acidity alone is almost nil, and that a meager correlation exists between resistivity and repairs. However, he gets a better correlation by plotting the product of "per cent repairs to date" times "ohm centimeters" in each soil type against milli-equivalents of acidity per 100 grams of soil. The straight line fitting the correlation best gives the relation:

$$P = \frac{8{,}000\ (A - 5)}{R}$$

Where:

P = per cent of line repaired in one soil type (33 years).
A = average milli-equivalents of acidity in that soil.
R = average ohm centimeters resistivity of that soil.

A and R are averages over wide areas for each type of soil. Economic criticism of this relation is obtained by determining at what value of P coatings should have been used, by the cut-and-try method illustrated above. In the example cited, a saving of 16 per cent could have been realized in total maintenance cost up to the time of investigation. Ewing also classifies the soils according to corrosiveness as indicated by experienced corrosion alone, and again applies the economic test to the coating problem. As expected, this gives the best answer, and reduces further tests to identifying soils.[9]

It is evident that, in these soil types, a useful survey would be one that determined total acidity and resistivity. The soil-survey data could be used to determine how much and where a coating should be used.

By inspection it is seen that this formula breaks down if A approaches 5 milli-equivalents of acid per 100 grams. Its use is *a priori* limited to the soils from which experience is drawn. From what we know of corrosion activity in mildly acid soils, the above relationship is not unreasonable.

Conclusion

In conclusion, we might outline a rational procedure of surveying soils, and of establishing from the survey data a useful criterion for pipe protection.

A. The rational procedure to follow in soil testing.

The technologist should bear in mind the ultimate use to which the survey will be put, and the principles of corrosion in its many forms in different soils. He should then:

(Continued on Page 128)

Suitability of Some Casing Steels for Field Welding

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During the past year the problem of the effect of quenching on circumferential welds in casing has been investigated in several places; the results of these several investigations have been assembled in this paper with the purpose of serving as a guide for the suitability of several steels for field welding of casing. It is the intention in presenting this paper to endeavor to suggest a definition of casing weldability and to draw some conclusions as to the suitability of various steels for casing which

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is to be welded. It is believed, however, that even though these results indicate a serious effort on the part of experimenters to investigate the problem of quenching, that probably no one should insist on final conclusions at this time. The principal reason for presenting this paper is that as a result of these tests a considerable amount of information is available on the relative adaptability of several steels to field welding, and it is probably important that this information be made available to those who are engaged in welding their casing and to those who are manufacturing casing for welding. The paper itself then should be considered in the nature of a progress report from which we have the right to draw conclusions if we feel able to do so.

Before proceeding to the tests we should define our meaning of the word "weldability" in this paper. By weldability we mean that quality of the steel which makes it possible for a competent welder, using proper equipment and technique, to puddle the steel without undue difficulty, with the further condition that the steel should be of such a nature that after it has been welded it should be possible to immerse it in water within a relatively short time, such as one minute, without unduly affecting its tensile strength or ductility.

Inasmuch as these tests have been made in a number of different places and by a number of different investigators, the procedures and techniques have varied somewhat from place to place. In general, the procedure was to use butt joints of casing which were sufficiently long to be handled readily in tensile strength machines after the completion of the weld. Most of the welds were made with the pipe in a vertical position as it would be at the well. In each case where the pipe was 7 inches O.D. or greater, three welders were used; where the pipe was less than 7 inches O.D. only two welders were used. After completion of the welds, they were, in some cases, pulled in full sections, and in others, joints were split up into coupons which were pulled and bent.

TABLE 1—MOLYBDENUM STEEL—FIRST SERIES OF TESTS

Quenched after	Joint number	Tensile strength pounds/square inch: Low	Tensile strength pounds/square inch: Average	Joint efficiency per cent	Normal bend degrees: Low	Normal bend degrees: Aver.
0 Seconds	1	21,300	61,300	57	0	4
0 Seconds	2	15,700	59,000	55	0	2
0 Seconds	3	54,000	83,000	77	5	26
Average of averages			68,000	63		10
15 Seconds	4	17,800	42,500	39	0	0
15 Seconds	5	35,600	82,800	77	0	23
15 Seconds	6	35,200	78,900	73	0	14
Average of averages			68,000	63		12.3
30 Seconds	7	34,000	72,700	68	0	14
30 Seconds	8	28,900	84,566	79	0	22
30 Seconds	9	51,600	78,000	72	0	28
Average of averages			78,400	73		21.3
1 Minute	10	69,200	97,900	91	14	48
1 Minute	11	62,600	90,800	84	0	36
1 Minute	12	61,400	85,200	79	20	38
Average of averages			91,296	85		40.6
2 Minutes	13	96,500	107,000	99	27	76
2 Minutes	14	88,900	102,700	95	10	39
2 Minutes	15	82,300	100,000	93	30	56
Average of averages			103,230	96		57
3 Minutes	16	106,200	108,200	100	18	54
3 Minutes	17	75,300	104,100	97	25	76
3 Minutes	18	86,900	102,600	95	38	57
Average of averages			103,960	97		62
Air cooled	19	92,600	100,450	93	29	57
Air cooled	20	79,000	103,400	96	29	61
Air cooled	21	87,800	104,000	97	38	74
Average of averages			102,635	95		64
Preheated to 250° and air cooled	22	94,700	100,600	93	44	63
Preheated to 250° and air cooled	23	90,000	103,900	97	32	76
Preheated to 250° and air cooled	24	100,600	103,200	96	35	74
Average of averages			102,850	96		71

TABLE 2

Joint number	Quenched after	Joints: Tensile strength: Low	Joints: Tensile strength: Average	Joints: Joint efficiency per cent	Bends: In degrees: Low	Bends: In degrees: Average	Per cent elongation of welds: Low	Per cent elongation of welds: Average
25	Immediately	16,180	39,320	39	0	22	0	32
26	15 Seconds	0	40,140	40	0	13	0	5
27	30 Seconds	35,490	50,920	51	0	13	0	6
28	1 Minute	30,240	60,810	61	0	22	0	10
29	2 Minutes	76,810	85,690	85	42	62	20	31
30	3 Minutes	80,460	89,560	89	33	49	19	26
31	Air cooled	86,410	89,610	89	26	75	14	37
32	Air cooled	76,700	88,470	88	32	58	20	29

The exact conditions that obtained in each test will be indicated.

Molybdenum Steels

Some experience has been had with steels containing molybdenum. The results had from the welding and quenching tests will be found in Tables 1, 2 and 3.

Conditions of First Series of Tests

Three welders welding simultaneously, three-sixteenths inch electrodes, and making three beads. Tensile strength of electrode, 100,000 pounds per square inch. Pipe in vertical position. All bends were around a 1-inch mandrel. Three nipples welded and quenched at each time interval. Each nipple split into 12 coupons (six tensile and six bend). Low and average of each group of tests tabulated. Average strength of casing, 107,600 pounds per square inch. Average normal bend of casing stock coupons around 1-inch mandrel, 180 degrees. Casing size, 7-inch x .362. (Table 1.)

CHEMICAL ANALYSIS

C	Mo	Mn	S	Si	P
.34	.43	1.32	.028	.21	.018

TABLE 3—RESULTS OF FULL JOINT PULLS

Joint number	Quenched after	Tensile strength	Joint efficiency per cent
33	30 Seconds	48,350	45
33	30 Seconds	36,030	33
33	30 Seconds	45,380	42
	Average	43,250	40
34	1 Minute	59,270	55
34	1 Minute	81,860	76
34	1 Minute	58,600	54
	Average	66,576	62
35	2 Minutes	81,920	76
35	2 Minutes	96,550	90
35	2 Minutes	96,140	89
	Average	91,536	85
36	3 Minutes	93,780	87
36	3 Minutes	96,940	90
36	3 Minutes	95,870	89
	Average	95,530	89
37	4 Minutes	86,300	80
37	4 Minutes	91,750	85
37	4 Minutes	93,950	87
	Average	90,666	84

Molybdenum Steel—Second Series of Tests—Conditions of Tests

Three welders welding simultaneously. Three-sixteenths inch electrodes. Three beads. Tensile strength of electrode, 85,000 pounds per square inch. Pipe in vertical position. All bends made around a 1-inch mandrel. Each nipple split into

nine coupons (five tensile and four bend). Low and average of each group of tests tabulated. Casing size, 8⅝-inch x .400. (Table 2.)

Physicals:

Yield	Tensile strength	Elongation 2"	Elongation 8"	Per cent reduction in area	Bend test	Rockwell hardness
82,600	100,400	30.0	29.0	49.5	O.K	C-21

Chemical check:

C	Mn	P	S	Si	Mo
.32	1.35	0.19	.014	.31	.48

Tensile strength of electrode—85,000 lbs./sq. in.

Molybdenum Steel—Third Series of Tests—Conditions of Tests

Three welders welding simultaneously. Three-sixteenths-inch electrodes. Three beads. Tensile strength of pipe, 107,600. Pipe in vertical position. One joint made under each quenching condition. Three strips cut from each joint. Individual and average values for the three coupons from each joint are tabulated. Casing size, 7 inches x .362. (Table 3.)

Chemical analysis:

C	Mo	Mn	S	Si	P
.34	.43	1.32	.028	.21	.018

Tensile strength of electrode—85,000 lbs./sq. inch.

Copper Steels

Tests on copper steels have been divided into two classifications: Namely, those in which the copper content is approximately .50 per cent, and those in which the copper content is approximately 1 per cent.

Conditions of First Series of Tests on .50% Copper Steel

Seven-inch O.D., 24-pound casing.

Three welders welding simultaneously on a butt weld, using three-sixteenths inch electrode and making two beads. Tensile strength of electrode, 85,000 pounds per square inch. Pipe in same position as when welding casing. All bends made around 1-inch mandrel. Average tensile strength of casing, 81,000 pounds per square inch. Chemical analysis, C—.206, Mn.—1.112, Cu—.45. 6 tensiles, 6 bends to each joint. (Table 4.)

Conditions of Second Series of Tests on .50% Copper Steel

Three welders welding simultaneously on a butt weld making three beads. Five-thirty-seconds inch electrode used on the first bead, three-sixteenths inch electrode used on second and third beads. Tensile strength of electrode, 85,000 pounds per square inch. Pipe in vertical position. All bends made around 1-inch mandrel. Casing size, 8⅝-inch by .400. Nipples split into nine coupons (five tensile, 4 bend). Low and average value for each nipple tabulated. (Table 5.)

Physicals:

Yield	Tensile Strength	Elongation 2"	Elongation 8"	Per cent reduction in area	Rockwell hardness
60,500	75,350	38.2	17.3	56.5	C—2.5

Chemical check:

C	Mn	P	S	Si	Cu
.22	1.12	.017	.017	.011	.53

Conditions of Third Series of Tests on .50% Copper Steel

All tests were made on 7-inch O.D. x .362-inch gauge.

Two short pieces about 8 inches long, prepared with a "U" bevel, were used for each weld. The welding was done in a vertical position with the ends slightly less than one-sixteenth inch apart, and placed in a jig constructed so as to bring the weld about shoulder height. Five-thirty-seconds inch electrode was used with arc current averaging about 150 amperes for the first bead, this being as large a coated electrode as could be used on the bottom of the "U" groove without interference. Two beads using three-sixteenths inch electrode with an arc current averaging 150 amperes were then deposited. Three welders worked simultaneously on each weld. The spot where last arc was broken was marked with hot-chalk. This location for the test coupon was chosen because it was felt that it gave the most conservative results, since the quench effect should be the most pronounced at this point, and the chance of getting porosity in the weld metal is greater. This should be kept in mind in comparing these results with average values from a number of coupons taken around the circumference. Quenching was accomplished by placing the welded joint in a tank of cold water. The shortest practical time for doing this appeared to be five seconds, so this time interval was used for joints 77, 78, 89 and 90. After cooling, a strip about one inch wide (actually 0.975-inch) was milled out for the tensil tests at the position marked. (Tables 6 and 7.)

TABLE 4

Joint number	Quenched after	Tensile strength lbs. per sq. in. Low	Tensile strength lbs. per sq. in. Average	Joint efficiency per cent	Normal bend degrees Low	Normal bend degrees Average
38	0 Seconds	68,100	78,100	96	20	61
39	15 Seconds	54,100	74,000	91	22	71
40	30 Seconds	72,400	78,900	97	44	79
41	1 Minute	67,100	77,300	95	84	102
42	1½ Minutes	62,000	77,700	96	58	83
43	2 Minutes	55,400	77,800	96	28	101
44	2½ Minutes	64,900	75,600	93	75	166
45	Air cooled	74,300	79,400	98	85	154

(All conditions the same as above except that a 100,000 pounds per square inch electrode was used instead of the 85,000 pounds per square inch electrode.)

46	0 Second	67,300	78,600	97	20	51
47	15 Seconds	73,500	80,300	99	56	83
48	Air cooled	73,400	80,300	99	58	113

TABLE 5

		Joints			Bends			
		Tensile strength			In degrees		Per cent elongation of welds	
Joint number	Quenched after	Low	Average	Joint efficiency per cent	Low	Average	Low	Average
49	Immediately	68,650	73,070	97	0	110	0	19
50	15 Seconds	70,890	73,690	98	38	114	5	30
51	30 Seconds	69,350	71,840	95	42	110	13	29
52	1 Minute	66,690	71,880	95	74	116	18	28
53	2 Minutes	61,150	71,540	95	130	155	23	35
54	3 Minutes	71,360	73,570	98	66	136	22	33
55	Air cooled	64,740	71,380	95	54	133	19	28
56	Air cooled	66,890	71,370	95	120	140	20	33

TABLE 6—ELECTRODE—TENSILE STRENGTH 85,000 POUNDS

Quenched after	Joint number	Tensile strength Low	Tensile strength Average	Joint efficiency per cent	Bends In degrees Low	Bends In degrees Average	Bends Per cent elongation Low	Bends Per cent elongation Average
30 Seconds	81	50,160	70,650	70	12	48	3.2	30.4
30 Seconds	82	68,280	85,950	86	23	51	15.6	25.6
Average of averages			78,300	78	..	49.5	..	28
1 Minute	83	74,550	82,640	83	54	59	33.3	36.3
1 Minute	84	77,200	86,500	86	46	57	7.9	25
Average of averages			84,570	84	..	58	..	30.6
2 Minutes	85	70,940	79,350	79	37	78	20	46
2 Minutes	86	72,940	85,570	85	33	52	18	28
Average of averages			82,460	82	..	65	..	37
Air coiled	87	73,490	80,130	80	86	123	51.7	69.4
Air cooled	88	80,610	87,700	88	87	115	45.2	55.7
Average of averages			83,910	84	..	119	...	62.5

Chemical Tests on Pipe

Joint No.	C	Mn	P	S	Cu
57 to 68	.23	1.14	0.18	.039	.45
69 to 80	.21	1.02	.015	.032	.45

Physical Tests on Pipe

Joint No.	Yield	Tensile	Per cent elongation in 2"	Per cent reduction in area	Brinell
57 to 68	61,430	83,100	34	49.3	159
69 to 80	60,500	78,180	35	50.5	153

TABLE 6—PHYSICAL TEST DATA WELDED WITH 85,000-POUND ELECTRODE

Joint number	Time before quenching	Yield lb./sq. in.	Tensile lb./sq. in.	Joint efficiency per cent
57	3 Minutes	60,320	77,620	93
58	3 Minutes	59,620	77,960	94
59	2 Minutes	63,730	79,530	96
60	2 Minutes	60,000	77,660	93
61	1 Minute	55,200	79,430	96
62	1 Minute	54,030	78,610	95
63	30 Seconds	63,020	72,540	87
64	30 Seconds	59,560	67,380	81
65	15 Seconds	58,600	79,260	95
66	15 Seconds	60,760	63,900	77
67	5 Seconds	61,280	64,440	78
68	5 Seconds	.....	59,780	72

TABLE 7—PHYSICAL TEST DATA WELDED WITH 65,000-POUND ELECTRODE

Joint number	Time before quenching	Yield lb./sq. in.	Tensile lb./sq. in.	Joint efficiency per cent
69	3 Minutes	60,600	76,600	98
70	3 Minutes	59,680	76,700	98
71	2 Minutes	63,560	75,660	97
72	2 Minutes	58,900	77,160	99
73	1 Minute	60,190	77,380	99
74	1 Minute	60,010	73,860	94
75	30 Seconds	60,400	69,500	89
76	30 Seconds	61,180	77,560	99
77	15 Seconds	60,090	76,700	98
78	15 Seconds	60,720	73,620	94
79	5 Seconds	60,760	77,360	99
80	5 Seconds	61,150	77,300	99

First Series of Tests on 1% Copper Steel Casing

After tests on steels with small amounts of copper had been concluded, tests were made on steels with 1 per cent copper.

5½-inch x .304 gauge.

Chemical analysis:

	C	Mn.	P	S	Cu.
Ladle	.22	1.37	.017	.022	1.02
Check	.23	1.31	.016	.023	...
Check	.21	1.41	.015	.023	...

Physical data:

Yield	Tensile	Elong. 2-inch	Red. area	Brinell
83490	99,850	30%	49.4%	228
83260	100,600	27	47.6	217

This pipe was V notched at the 70° included angle and the root of the notch, within one-sixteenth inch of entirely through the pipe. The welding was then done by two welders working siumltaneously, making a butt weld with the pipe in a vertical position. At the completion of the weld the specimen was plunged in cold water after a pre-arranged time interval. When cool the specimen was cut into ten strips, five of which were used for tensile tests and five for bends. The time intervals used were 30 seconds, 1 minute, 2 minutes and an indefinitely long period sufficient for the specimen to cool in air. The air-cooled specimen was, of course, not quenched in water. This entire procedure was gone through

with three different electrodes. These electrodes were well recognized commercial electrodes with tensile strengths of 65,000, 85,000, and 100,000 pounds per square inch. (Tables 8, 9, 10.)

Second Series of Tests on 1% Copper Steel —Conditions of Tests

Three welders welding simultaneously on a butt joint, using three-sixteenths inch electrode and making three beads. Tensile strength of electrode, 85,000 pounds per square inch. Pipe in vertical position. All bends made around one-inch mandrel. Casing size, 8⅝-inch x .400. Nipples split into 9 coupons (5 tensile and 4 bend). Low and average value for each nipple tabulated. (Table 11.)

Physicals:

Yield	Tensile strength	Elongation 2"	Elongation 8"	Per cent reduction in area	Rockwell hardness
77,050	96,500	30.6	15.4	48.5	C—14.5

Chemical check:

C	Mn	P	S	Si	Cu
.19	.99	.017	.023	.015	.98

First Series of Tests on Cold Worked Steel —Conditions of Tests

Three welders welding simultaneously on a butt joint. Three beads. Five-thirty-seconds inch electrode on first bead, three-sixteenth inch electrode on second and third beads. Casing in vertical position. Samples for testing were taken from points in the circumference where last two welders broke arc. Tensile strength of electrode, 85,000 pounds per square inch. Casing size, 8⅝-inch x .400. (Table 12.)

Chemicals:

C	Mn
.30	1.35

Physicals (two tests):

Ultimate tensile strength	Yield	Per cent elongation in 2 inches
86,020	74,200	30.5
84,500	71,500	37.5

TABLE 12—RESULTS OF QUENCHING WELDS

Joint number	Code	Quenching time	Tensile strength lb./sq. in.	Joint efficiency per cent
113	P-1	Immediately	89,500	100
114	N-1	Immediately	78,600	93
115	P-2	15 Seconds	86,600	100
116	N-2	15 Seconds	85,000	100
117	P-3	30 Seconds	81,550	95
118	N-3	30 Seconds	76,800	91
119	P-4	1 Minute	88,900	100
120	N-4	1 Minute	79,200	94
121	P-5	2 Minutes	94,800	100
122	N-5	2 Minutes	78,800	93
123	P-6	3 Minutes	89,300	100
124	N-6	3 Minutes	87,600	100

Second Series of Tests on Cold Worked Steel —Conditions of Tests

10¾-inch O.D.—35-pound butt joint.

Three welders, welding simultaneously, using three-sixteenths inch electrode and making three beads. Tensile strength of electrode, 85,000 pounds per square inch. Pipe in vertical position. All bends made around one-inch mandrel. Six tensile and 6 bend tests were taken. Low and average value of each group tabulated. Average tensile strength of casing, 94,500 pounds per square inch. Chemical analysis: C—0.269, Mn—1.426. (Table 13.)

Third Series of Tests on Cold Worked Steel —Conditions of Tests

Three welders welding simultaneously, using three-sixteenths inch electrode and making three beads. Tensile strength of electrode, 85,000 pounds per square inch. Pipe in vertical position. Six tensile and 6 bend tests were taken. Low and average value of each group tabulated. Pipe size, 8⅝-inch x .400. (Table 14.)

Physicals:

Yield	Tensile strength	Elongation 2 inches	Elongation 8 inches	Per cent reduction in area	Rockwell hardness
77,600	84,200	29.5	10.4	49.5	C-6.5

Chemical check:

C	Mn	P	S
.22	1.33	.015	.014

First Series of Tests on Medium Carbon—Manganese Steel—Conditions of Tests

Two welders welding simultaneously on a butt weld, using three-sixteenths inch electrode and making two beads. Tensile strength of electrode, 65,000 pounds per square inch. Pipe in vertical position. Five tensile and 4 bend samples cut from each joint. Low and average values of each group tabulated. Casing size, 5½-inch x .244. (Table 15.)

Physicals:

Treatment	Tensile strength	Normal bend degrees
As received	59,930	84,260	180
Heated to a bright red and quenched immediately in water	.....	162,500	32

Chemicals:

C	Mn	P	S	Si
.25	1.34	.019	.025	.24

Second Series of Tests on Medium Carbon—Manganese Steel—Conditions of Tests

Two welders welding simultaneously on a butt weld, using three-sixteenths inch electrode and making two beads. Tensile strength of electrode. 65,000 pounds per square inch. Pipe in vertical position. Five tensile and 4 bend samples cut from each joint. Low and average values of each group tabulated. Casing size, 5½-inch x .304. (Table 16.)

Physicals:

Treatment	Yield	Tensile strength	Normal bend degrees
As received	57,500	88,060	180
Heated to a bright red and quenched immediately in water		528 Brinell	29

Chemicals:

C	Mn	P	S	Si
.32	.90	.028	.020	.20

High Carbon—Manganese Steel—Conditions of Tests

Three welders welding simultaneously on a butt weld, using three-sixteenths inch electrode and making three beads. Pipe in vertical position. Tensile strength of electrode, 85,000 pounds per square inch. Each joint was split into five tensile and four bend coupons. Low and average value

TABLE 9—ELECTRODE—TENSILE STRENGTH 85,000 POUNDS

Quenched after—	Joint No.	Tensile strength Low	Tensile strength Average	Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent elongation in bends Low	Bends: Per cent elongation in bends Average
30 Seconds	89	67,530	78,320	78	33	50	21	32.2
30 Seconds	90	97,000	97,470	97	34	55	11	28.0
	..	.....	87,890	88	..	52.5	..	30.6
1 Minute	91	76,480	88,900	89	22	64	19	36.3
1 Minute	92	80,260	89,740	90	45	64	25	34.3
	..	.....	89,320	89	..	64	..	35.3
2 Minutes	93	83,650	90,160	90	43	66	25	38.7
2 Minutes	94	97,870	98,540	98	63	74	28	42.4
	..	.....	94,350	94	..	70	..	40.5
Air cooled	95	77,770	80,920	81	22	104	42	60.1
Air cooled	96	90,410	95,170	95	115	140	41	57.2
	..	.....	88,045	88	..	122	..	58.6

TABLE 10—ELECTRODE—TENSILE STRENGTH 100,000 POUNDS

Quenched after	Joint number	Tensile strength Low	Tensile strength Average	Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent elongation Low	Bends: Per cent elongation Average
30 Seconds	97	73,710	90,220	90	11	76.4	33	47.6
30 Seconds	98	90,100	93,860	94	25	57.4	9	24.2
Average of averages			92,040	92		66.9	..	35.9
1 Minute	99	76,120	91,140	91	13	64	25	34.1
1 Minute	100	70,700	92,830	93	14	64	3	37
Average of averages			91,985	92	..	64	..	35
2 Minutes	101	93,610	94,880	95	56	118	21	46.8
2 Minutes	102	77,660	91,080	91	40	67	22	32.6
Average of averages			92,980	93		92.5	..	39.7
Air cooled	103	95,290	96,680	97	49	73	18	32.5
Air cooled	104	94,340	96,180	96	52	79	21	38.6
Average of averages			96,430	96	..	76	..	35.6

TABLE 11

Joint No.	Quenched after—	Joints: Tensile strength Low	Joints: Tensile strength Average	Joints: Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent elongation of welds Low	Bends: Per cent elongation of welds Average
105	Immediately	65,820	75,540	78	54	109	20	34
106	15 Seconds	71,130	76,220	79	33	94	6	29
107	30 Seconds	66,500	72,560	75	76	129	9	30
108	1 Minute	70,700	76,970	80	70	110	30	34
109	2 Minutes	72,020	77,910	81	102	130	37	33
110	3 Minutes	71,690	77,910	81	42	124	30	49
111	Air cooled	72,090	74,480	77	70	121	21	36
112	Air cooled	65,680	76,550	78	79	118	25	34

TABLE 13

Joint No.	Quenched after—	Sample No.	Tensile strength lbs. per sq. in. Low	Tensile strength lbs. per sq. in. Average	Joint efficiency per cent	Normal bend degrees Low	Normal bend degrees Average
125	0 Second	1	71,200	84,633	90	14	100
126	15 Seconds	1	57,800	86,787	92	2	99
127	15 Seconds	2	78,900	89,811	95	81	111
128	15 Seconds	3	81,600	90,500	96	38	81
	Average of averages		.....	89,036	94	..	97
129	30 Seconds	1	75,600	91,200	97	111	123
130	1 Minute	1	67,600	87,800	93	85	123
131	1½ Minutes	1	81,400	89,200	94	33	94
132	2 Minutes	1	80,400	89,000	94	60	108
133	2½ Minutes	1	81,100	90,700	96	56	118
134	3 Minutes	1	82,400	91,100	96	48	104
135	3½ Minutes	1	85,300	92,600	98	60	116
136	Air cooled	1	76,500	92,100	97	63	97

(All conditions the same as above, except that 100,000 pounds per square inch electrode was used, instead of the 85,000 pounds per square inch electrode.)

137	0 Second	1	75,300	90,300	96	18	107
138	15 Seconds	1	80,900	91,700	97	50	102
139	Air cooled	1	92,800	93,800	99	69	109

of each group tabulated. Casing size, 8⅝-inch x .400. (Table 17.)

Physicals:

Yield	Tensile strength	Elongation 2"	Elongation 8"	Per cent reduction in area	Rockwell hardness
63,750	100,900	27.0	13.4	50	C-17

Chemical check:

C	Mn	P	S	Si
.45	1.32	.02	.02	.29

Interpretation of Results

Thus far, no effort has been made to discuss the meaning of the data presented. It is the intention at this point to propose a method for measuring results. An attempt was made to define weldability so far as it is applied to casing steel and field welding in the introduction to this paper. In order to give exact meaning to this rather abstract definition, it is proposed that in order for a casing steel to be considered as weldable, it should be welded and tested under the procedures practiced in the assembling of the data in this paper and that the results will show (1) that at one minute and longer time intervals following quenching, the bend

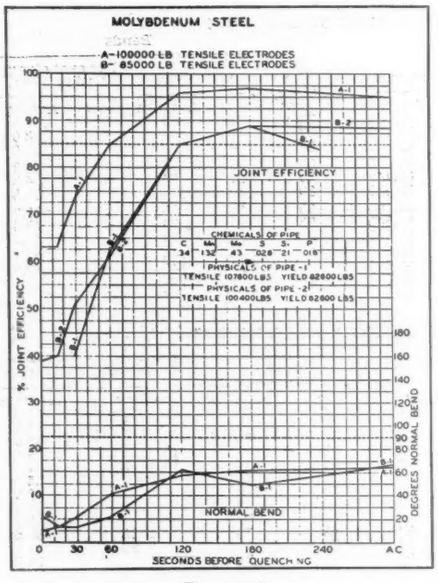

Figure 1

samples will average a 90° bend and (2) at time intervals of one minute and longer after quenching, the tensile samples will show an average joint efficiency of 85 per cent.

In order that this method of gauging the weldability of casing steel may become usable, it is necessary to standardize the tests in every detail, and this will be done further on in the paper. At this time, let us consider the results of setting up such a method of measuring weldability. In Figure 1 will be found curves illustrating the variation in joint efficiency and ductility as indicated by the pulls and normal bends of samples of the molybdenum steel that have been quenched at different time intervals. It will be immediately evident that by the measure we have set up, this should not be regarded as a weldable steel.

This agrees exactly with our experience in attempting to make use of this steel in welding casing. Attempts to use this steel have been unsuccessful except when a waiting period before quenching of three minutes has been adopted. Where such a length of time was allowed to elapse before quenching, it was found possible to weld such steel successfully. It is not felt feasible, however, to wait such a length of time under ordinary conditions. This then, gives us an experience check on the validity of the standard we have set up. Before experience was had, it might have been noticed that it was possible to obtain 40° bends after allowing the steel to cool one minute before quenching, and the experimenter might have argued that inasmuch as the casing was never bent 40° at one place in going down the hole, such a bend should be adequate. Experience has shown

TABLE 14

Joint number	Quenched after	Joints: Tensile strength Low	Joints: Tensile strength Average	Joints: Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent elongation of welds Low	Bends: Per cent elongation of welds Average
140	Immediately	80,580	84,680	100	0	79	12	20
141	15 Seconds	81,250	85,010	100	143	171	29	38
142	30 Seconds	78,200	83,760	99	69	110	15	28
143	1 Minute	85,470	86,260	100	119	153	19	28
144	2 Minutes	76,470	83,730	99	73	129	17	19
145	3 Minutes	77,920	82,340	98	122	165	20	39
146	Air cooled	78,920	82,890	98	47	74	2	11
147	Air cooled	73,840	79,430	94	37	117	11	26

TABLE 15

Joint number	Quenched after	Joints: Tensile strength Low	Joints: Tensile strength Average	Joints: Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent elongation of welds Low	Bends: Per cent elongation of welds Average
148	Immediately	15,780	60,150	71	10	63	0	11
149	Immediately	60,480	73,500	87	0	91	15	27
150	Immediately	65,040	75,740	90	180	180	35	55
	Average of averages	.....	69,790	83	..	111	..	31
151	15 Seconds	59,840	73,700	87	37	125	10	33
152	15 Seconds	63,690	72,300	86	5	124	10	45
153	15 Seconds	61,230	74,830	89	83	150	2	27
	Average of averages	.....	73,610	87	..	133	..	35
154	30 Seconds	67,650	79,140	94	34	97	14	29
155	30 Seconds	66,400	73,660	87	58	131	9	27
156	30 Seconds	67,160	71,060	84	49	154	14	40
	Average of averages	....	74,620	89	..	127	..	32
157	1 Minute	59,780	72,190	86	180	180	37	49
158	1 Minute	61,520	74,880	89	122	168	29	41
159	1 Minute	59,370	71,800	85	52	129	25	35
	Average of averages	.....	72,950	87	..	159		42
160	2 Minutes	78,060	81,150	96	180	180	52	54
161	2 Minutes	72,550	81,250	96	180	180	39	49
162	2 Minutes	52,060	71,130	84	92	162	16	36
	Average of averages	.....	77,840	92	..	174	..	46
163	3 Minutes	67,280	75,020	89	114	167	9	42
164	3 Minutes	57,360	71,890	85	55	155	22	47
165	3 Minutes	58,780	74,210	88	180	180	42	45
	Average of averages	....	73,700	87	..	167	..	43
166	Air cooled	55,020	66,960	79	180	180	34	52
167	Air cooled	63,440	76,250	90	49	154	14	34
168	Air cooled	64,720	72,030	85	180	180	32	44
	Average of averages	.....	71,740	85	..	171	..	43

TABLE 16

Joint number	Quenched after	Joints: Tensile strength Low	Joints: Tensile strength Average	Joints: Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent elongation of welds Low	Bends: Per cent elongation of welds Average
169	Immediately	52,620	69,700	79	10	48	0	8
170	Immediately	0	59,350	67	0	109	0	15
171	Immediately	26,590	62,480	74	31	95	0	14
	Average of averages	.....	63,840	72	..	84	.	12
172	15 Seconds	64,180	74,980	85	8	57	8	15
173	15 Seconds	65,700	76,530	87	30	56	6	10
174	15 Seconds	61,400	76,460	87	0	32	0	5
	Average of averages	.....	75,990	86	..	48		10
175	30 Seconds	65,390	81,050	92	51	132	11	17
176	30 Seconds	62,690	79,040	90	13	134	2	18
177	30 Seconds	70,480	86,970	99	28	145	11	18
	Average of averages	.....	82,350	94	..	137	..	18
178	1 Minute	75,030	81,340	92	163	176	16	24
179	1 Minute	63,440	83,280	95	141	177	22	25
180	1 Minute	78,790	87,420	99	55	112	15	16
	Average of averages	.....	84,010	95	..	155	..	22
181	2 Minutes	63,170	78,740	89	124	161	20	26
182	2 Minutes	72,860	83,560	95	153	174	23	26
183	2 Minutes	67,820	82,620	94	144	172	19	25
	Average of averages	.....	81,640	93	..	169	..	26
184	3 Minutes	71,590	85,300	97	46	138	10	27
185	3 Minutes	62,180	80,940	92	180	180	22	27
186	3 Minutes	69,750	84,490	96	180	180	24	28
	Average of averages	.....	83,570	95	..	169	..	27
187	Air cooled	60,340	71,260	81	133	160	24	28
188	Air cooled	71,510	83,130	94	56	120	0	19
189	Air cooled	70,290	83,630	95	116	167	21	27
	Average of averages	.....	79,340	90	..	149	..	25

TABLE 17

Joint number	Quenched after	Joints: Tensile strength Low	Joints: Tensile strength Average	Joints: Joint efficiency per cent	Bends: In degrees Low	Bends: In degrees Average	Bends: Per cent of elongation of welds Low	Bends: Per cent of elongation of welds Average
190	Immediately	63,660	85,700	85	6	74	0	23
191	15 Seconds	61,000	89,600	89	8	48	21	23
192	30 Seconds	0	80,910	80	0	34	0	7
193	1 Minute	69,890	86,450	86	38	83	16	26
194	2 Minutes	77,890	89,060	88	26	64	20	30
195	3 Minutes	61,780	85,240	84	62	69	24	30
196	Air cooled	92,310	97,980	97	38	105	16	35
197	Air cooled	80,890	90,160	89	122	128	35	41

us that this loss of ductility is clear evidence that residual stresses have been left in the metal in the heat-affected zone. These residual stresses, in the more extreme cases, have proven sufficient to cause cracks. Therefore, it has been found that even though this metal apparently will bend considerably beyond the point that the pipe may be expected to bend in being lowered into the hole, it is unsafe to use this casing when field welding is to be resorted to.

In Figure 2 will be seen the results had on .50 per cent copper steel. The evidence in this

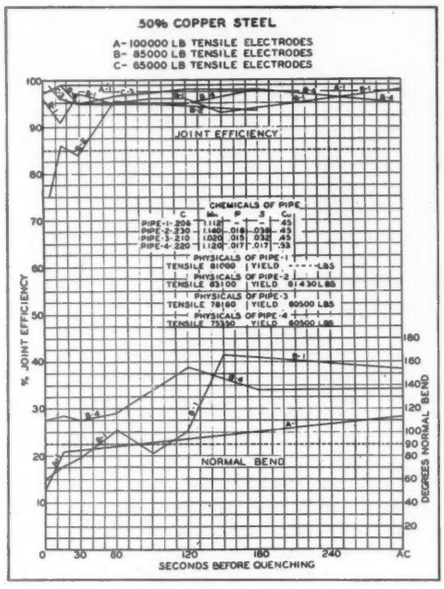

Figure 2

case indicates that this may be regarded as a weldable steel. The joint efficiencies after one-minute time interval before quenching are well above 90 per cent, and the normal bend values, allowing for experimental error, are above the 90° requirement. Here again experience checks our standard. We found in practice that this steel was a weldable steel, a great volume of it having been used with success.

In Figure 3 will be seen the results had on 1 per cent copper steel. In this case we find that with the exception of one pipe, namely the B-2, the other values do not meet the requirement for normal bend curves. They are, however, showing better joint efficiencies. In the case of the B-2 curves, we have a curious reversal, namely the bend test shows to be good, whereas the joint efficiency has dropped below the standard. Since these tests were carefully made and checked an explanation for this increase in ductility and decrease in tensile is not apparent at this time. It is doubtful whether it should be charged to experimental error.

The over-all result, however, is the same. In neither case does the pipe meet our standards for welding. So far as practical tests go, the writer does not have any experience of actually running this pipe into wells and therefore can not draw on parallel experience to indicate whether or not we are justified in stating that this steel should not be regarded as weldable. From the close analogy of the results had to those of other steels with which we have had experience, however, we should not be inclined to approve its use for casing that is to be field welded.

In Figure 4 will be found results had upon cold worked steel. This steel is all of what might be called a medium carbon, varying from .22 to .30. As will be seen from the curves, the joint efficiency is well above the minimum standard, averaging around 95 per cent, and the normal bend curves are above the 90° minimum throughout the entire time range. If our standards mean anything, this definitely is a weldable casing. We have had sufficient experience in actually welding this steel and running it in the hole to speak with confidence when we say that this steel has proven to be readily weldable from actual experience. The experience results, therefore, agree with this arbitrary test which we have set up.

In Figure 5 will be found the results had upon medium carbon-manganese steel. This steel varies from .25 to .32 carbon and as the curves indicate, may be considered as readily weldable under the standards set up. Experience had with such steels also indicate its weldability. It may be said that experience with such steels also indicate that the standard that has been set up is correct in classifying it as a weldable steel.

In Figure 6 will be found results had upon high carbon-manganese steel. It will be seen from the chemical analysis that this is simply the old

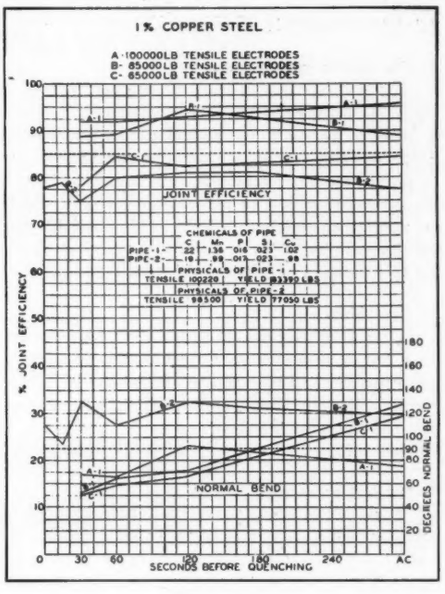

Figure 3

grade "D" steel. Results as indicated by the normal bend curve and by the standard we have set up would classify this steel as not satisfactory for field welding when used as casing. Here again we have a considerable amount of experience in welding on the old grade "D" steels to indicate that while it is possible to do so, the steel certainly can not be considered as a desirable welding steel.

Discussion of Test Results

Throughout the tests it will be seen that in general the effect of quenching at very short time periods is causing a decrease in tensile strength. It will be evident immediately, of course, to everyone that this is contrary to what is generally expected of quenching in steels. Quenching or the tempering of steels is always thought of as increasing the tensile strength and not decreasing. For that reason it is probably desirable that we point out here the reason for this apparent phenomenon.

Throughout the tests, a wealth of data was taken which it has not been deemed necessary to present along with this paper, as it is the aim of this paper to arrive only at general results and not to render a complete report of all the tests. Among the data taken were studies of Rockwell hardness distribution across the weld and the heat zone in the parent metal. In making these studies it was found regularly that the effect of the more violent quenching was, as was to be expected, a considerable increase in hardness. This increase in hardness of course meant that the tensile strength of the material had been increased. In spite of this fact it was found when the coupons were pulled that the tensile strength had decreased. Studies of etchings and microscopic studies of the weld and the vicinity in joints which had been voilently quenched, however, revealed that cracks were occurring. For the most part, these cracks were sub-visual but they were nevertheless effective. The explanation of our obtaining less tensile strengths in the more violently quenched sample is simply that while the hardness and the tensile strength of the metal has increased, the effect of the quenching has been to leave considerable residual stress in the metal and has also resulted in transformation to martensitic state of portions of the heat effected metal. These residual stresses and cracks which are usually found in martensitic structures are the explanation of why a hardened and strengthened metal is, on test, failing at a point which indicates less tensile strength. We are, in our tests, not measuring the actual tensile strength of the metal but are really measuring the net tensile strength which is the tensile strength of metal minus the amount that has to be deducted because the metal is cracked. It should be understood and it will have been noticed from examination of the tabulated data that this loss of

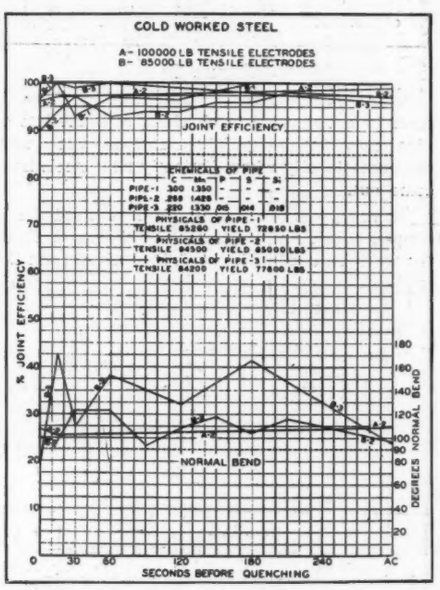

Figure 4

strength due to cracking and residual stress is not a small amount. Hardness tests indicate that brinell hardness will sometimes be found in excess of 500 and in a number of cases when the coupons were being machined some of those which represented joints which had been quenched at a very short time interval broke in two while in the shaper. Such an occurrence is of course possible only in a piece of metal that is already seriously cracked.

The following test procedure may at first thought seem too elaborate. It should be understood, however, that it is not the intention to go through this procedure every time a consumer receives a shipment of pipe. This procedure is intended to be used in the setting up of standards. It is intended to be used as it has been used in taking the data that have been submitted in

this paper. It is to be used on distinctly differing steels. Thus, unless other evidence that might come forward in the future should indicate the probable incorrectness of any of the data that has been submitted in this paper, these tests would not be repeated on the steels that have been covered here. This test procedure would be resorted to only when a manufacturer came out with a new steel. It will be seen then that this test, while entirely too elaborate to be used by a manufac-

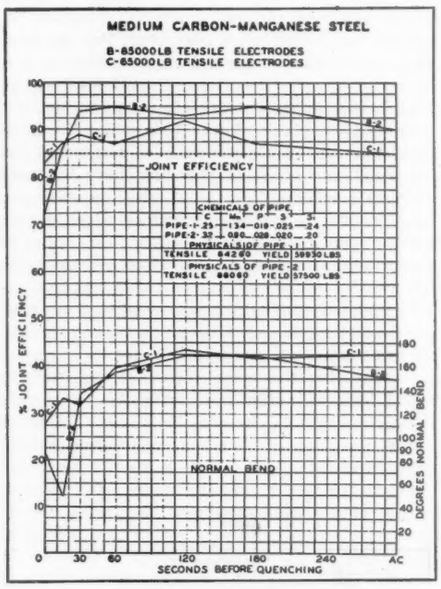

Figure 5

turer or a consumer in checking separate lots of pipe, may not be unduly elaborate when used only occasionally when distinctly new steels have come out.

It may well be that there is a need for a simple, cheap, and quick test by which to check the weldability of casing as it is received from the

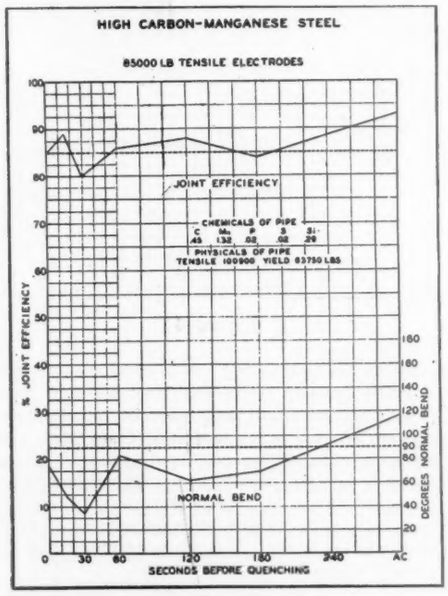

Figure 6

manufacturers but it is felt that such a test would itself necessarily have to be correlated with some such more elaborate test as this paper is proposing.

It is proposed then that for the present and for lack of any better method of measuring the suitability of casing steels for field welding, we do set up a standard which can be used for a measurement of this suitability. The availability of such a standard would make it possible for the various manufacturers and consumers to know, each what the other means, when he refers to suitability for welding, and until such a time as something more scientific has been devised, this might facilitate to quite an extent the development of weldable casing.

Conditions of Tests for Determining the Suitability of Casing Steels for Field Welding

1. Pipe.

At least three complete sets of tests are to be run on each of two thicknesses of pipe. One of these thicknesses is to be such that the nominal pipe wall is .25 or less. The other is to be taken on pipe of such a thickness that the nominal pipe wall is .400 or greater.

2. The joint.

A butt joint will be used. Any beveling of this joint is permissible.

3. The welding procedure.

1. Pipe may be spaced one-sixteenth inch if desired. 2. Any available electrode may be used. 3. On size casing 7-inch and larger, three welders will weld simultaneously. On size casing less than 7 inches in diameter, two welders will weld simultaneously. 4. The pipe, when welded, will be in a vertical position. 5. Two beads shall be used on the samples of lesser thickness and three beads on the samples of greater thickness.

4. Quenching.

After breaking arc, the pipe shall be quenched in a barrel or other container of water, the temperature of the water not to exceed 80° F. The interval following break of arc which is to precede the time at which quenching is to take place, to be one minute.

5. The test procedure.

1. *Sampling.*—The point on circumference of the weld where the last welder breaks arc on the final bead is to be marked. This mark is to be the mid-point of test coupon No. 1. The joint is to be split into five tensile and five bend tests, the bend and tensile coupons being taken alternately around the circumference. Coupons Nos. 1, 3, 5, 7 and 9 will be bend samples. Coupons Nos. 2, 4, 6, 8 and 10 will be tensile samples.

2. *Preparation.*—The bend and tensile coupons will be sawed or milled from the joint. It will not be permissible to cut them out with a torch. The bend and tensile coupons will then be prepared in accordance with Figure 7.

3. *The testing.*—The tensile strength will be pulled in the usual manner. The bend coupons are to be bent as illustrated in Figure 8, around a mandrel, the diameter of which shall not exceed three times the thickness of the finished bend sample. The bend is to be a normal bend with the outside of the weld on the outside of the bend. The bend shall be started in the "U" frame, illustrated in Figure 8, and carried far enough until it is possible to complete the bends between the plates of the testing machine. Bending of the bend coupons shall be stopped instantly upon occurrence of initial failure in the specimen.

6. Evaluation of results.

Joint efficiencies obtained and indicated by the tensile tests shall be averaged. These joint efficiencies are based on the tensile strength at failure of the coupon as compared with the tensile strength of an average of five pulls from the same joint of pipe, the samples taken from the pipe wall without any included weld. The average of the five joint efficiencies shall be considered satisfactory if it is at least 85 per cent. The angle through which the bend specimen has passed, up to the point when initial failure occurred shall be measured. The average of the five bend tests then shall be computed. If this average

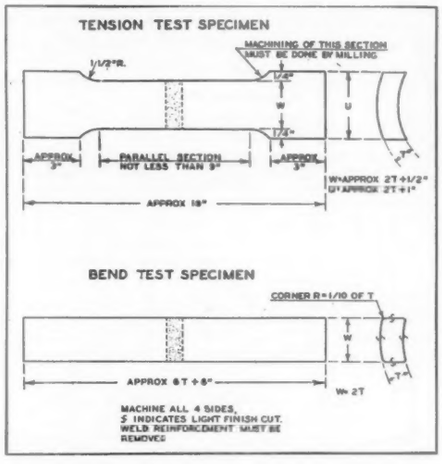
TENSION TEST SPECIMEN
MACHINING OF THIS SECTION MUST BE DONE BY MILLING
PARALLEL SECTION NOT LESS THAN 9"
APPROX 18"
BEND TEST SPECIMEN
CORNER R = 1/10 OF T
APPROX 6T + 6"
MACHINE ALL 4 SIDES.
INDICATES LIGHT FINISH CUT.
WELD REINFORCEMENT MUST BE REMOVED

Fig. 7—Preparation of samples for tensile and bend tests

is at least 90°, the bend tests shall be considered satisfactorily passed. If the bend and tensile samples of all six joints pass the test satisfactorily, the steel shall be considered satisfactory for use in casing which is to be field welded. If any of the joints fail, the entire test may be repeated as often as necessary to make sure that good average performance is being obtained and that experimental error is not leading to erroneous conclusions.

Acknowledgment is made for permission to publish the data contained in this paper to those who have borne the expense and labor of collecting it, namely: Phillips Petroleum Co., A. O. Smith Corp., National Tube Co., Republic Steel Corp. and Carter Oil Co.

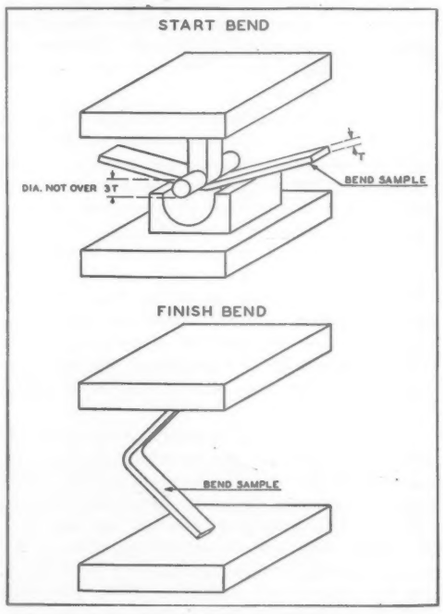

Fig. 8—Method of bending test samples

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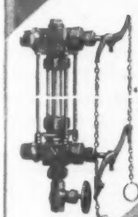

"Navy Type" Liquid Level Gage

"Safeguard" Automatic Liquid Level Gage

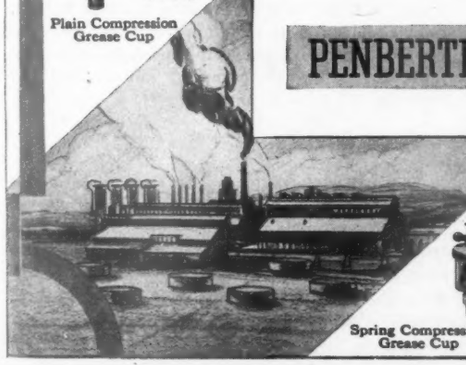
"All-Iron" Automatic Liquid Level Gage

Gas Engine Lubricator

Snap Lever Oiler

Plain Brass Oil Cup

Plain Compression Grease Cup



Screw Plunger Grease Cup

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• The Penberthy Reflex Gage shown here is recommended for working pressures to 350 lb. at 450°F. It is available in both Navy Bronze and Malleable Iron. Other Penberthy Reflex Gages are made in any length desired for higher pressures and for various kinds of liquids. Any leading oil well supply distributor will be pleased to quote upon your particular requirements.

PENBERTHY INJECTOR COMPANY *Manufacturers of* QUALITY PRODUCTS *Since 1886*
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Factors Which Influence Pumping Unit Selection

By DR. EMORY KEMLER
Gulf Oil Corp.*

A. Basis for Application of Units

The general application of a pumping unit must consider two factors, namely, maximum load rating and the peak torque rating.

The beam rating or maximum load rating determines beam stresses, bearing loads and pitman loading. While the maximum load is based on the A.P.I. allowable working stress for the beam

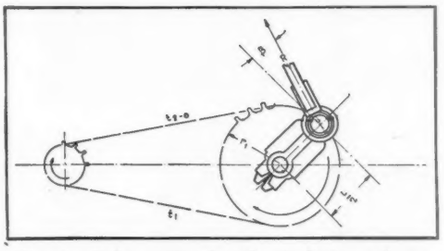

Fig. 1—Schematic sketch of chain reducer

it implies that the bearings are adequate to handle this load. This load also indirectly influences the overhung load on the crankshaft and peak torque.

Peak torque has become the method of checking the application of gear or chain units. This is the proper method of rating or applying gear units. For a given unit the torque gives a measure of gear-tooth pressure or chain pull. It should also be used in comparing standard fronts.

To illustrate how peak torque relates to gear-tooth pressures, chain pull and pitman load Figures 1, 2 and 3 will be considered. Considering the slow speed sprocket of a chain drive we see that the torque input to the sprocket is given by the expression:

$$T = (t_1 - t_2)r_1 \qquad (1)$$

If the pull on the slack side of the chain is negligible, i.e., $t_2=0$, then the peak torque is given by:

$$T = t_1 r_1 \qquad (2)$$

Or conversely, for a given peak torque the chain pull can be calculated. As chains normally fail by fatigue of the side links the safe value of t_1 is assumedly known and the peak torque of the unit can be calculated. If it is desired, this peak torque can be expressed in terms of the pitman pull. This can be expressed as:

$$T = (t_1 - t_2)r_1 = R\frac{L}{2}\cos\beta \qquad (3)$$

For all practical purposes, and certainly within the limits with which the safe peak torque is known or the peak load can be calculated, the pitman pull can be considered as being the polished rod load less the net counterbalance effect. If this be the case, then we have:

*Author's title: "Factors Influencing the Application of Pumping Units."

$$T = (t_1 - t_2)r_1 = R\frac{L}{2} \qquad (4)$$

For a more exact solution the equations can be developed on the following basis. The effective

A.P.I. — Paper presented at annual meeting, Chicago, 1938

load which is the polished rod load less effective counterbalance is given by:

$$Pe = \frac{Pl - Wl_2}{l} = P - \frac{Wl_2}{l} = P - Wc \qquad (5)$$

The pitman pull is given by the expression:

$$R = \frac{Pe}{\cos\theta} \qquad (6)$$

The peak torque can then be written as:

$$T = (t_1 - t_2)r = \frac{L}{2}R\cos\beta$$

$$= \frac{L}{2}\frac{(P - Wc)}{\cos\theta} \times \cos\beta \qquad (7)$$

Figure 3 illustrates the forces involved in a single reduction gear unit. The force between the gear teeth, F, is assumed as that force which

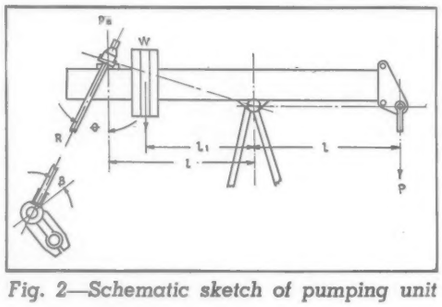

Fig. 2—Schematic sketch of pumping unit

would act on the pitch line at the point of tangency of the two-pitch circles. The torque on the low-speed shaft is given by:

$$T_{LS} = Fr_1 = \frac{L}{2}R\cos\beta \qquad (8)$$

The torque on the high-speed shaft is given by:

$$T_{HS} = Fr_2 = (t_1 - t_2)r_2 \qquad (9)$$

As the work done on the high-speed shaft must equal the work done by the low-speed shaft (assuming no friction) the following relation must be fulfilled:

$$N_2 T_{HS} = N_1 T_{LS} \quad \text{or,}$$
$$Fr_2 N_2 = Fr_1 N_1 \qquad (10)$$

That is, the torque on the low-speed shaft will always be larger than the torque on the high-speed shaft by a ratio of the high- and low-shaft speeds.

The peak torque rating of a gear unit is determined by the factors given in the A.P.I. specifications for the rating of pumping units. The horsepower rating of a gear unit is an arbitrary value based on the assumption that the peak

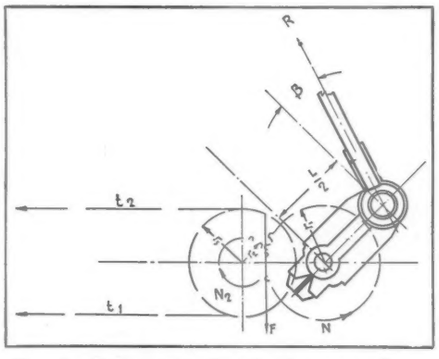

Fig. 3—Schematic sketch of gear reducer

torque is 1.57 times the average torque. It is, therefore, the horsepower rating for a gear handling a constant load of $\frac{1}{1.57}$ times the peak torque rating. Normally the peak torque will be more than 1.57 times the average torque so that a unit applied on the basis of horsepower will be overloaded. (Reference to horsepower ratings was deleted from Standards No. 11-E at the Wichita meeting, May 1938.*)

B. Formulas for Determining Range of Application

1. General formulas for maximum rod load.

As can be seen from the above formulas the maximum rod load is a very important factor in determining the peak torque. Where dynamometer cards are available the peak load can be read from them but for considering general cases general formulas must be used. Two general formulas will be used in this discussion. The first, which will be used in making specific calculations because of its simplicity, is that developed by Slonneger and given in the A.P.I. specifications for rating of pumping units. This formula is:

$$P = (Wr + Wo)\left(1 + \frac{NL}{5{,}400}\right) \qquad (11)$$

The other formula is that assuming simple harmonic motion and used for calculating rod loads. For normal speeds the agreement between these two formulas is within the actual variations encountered in practice. At high speeds the A.P.I. formula gives loads which are not high enough. As the maximum load under these condi-

*A.P.I. Standards No. 11-E: "Specifications for Rating of Speed Reducers for Pumping Machines."

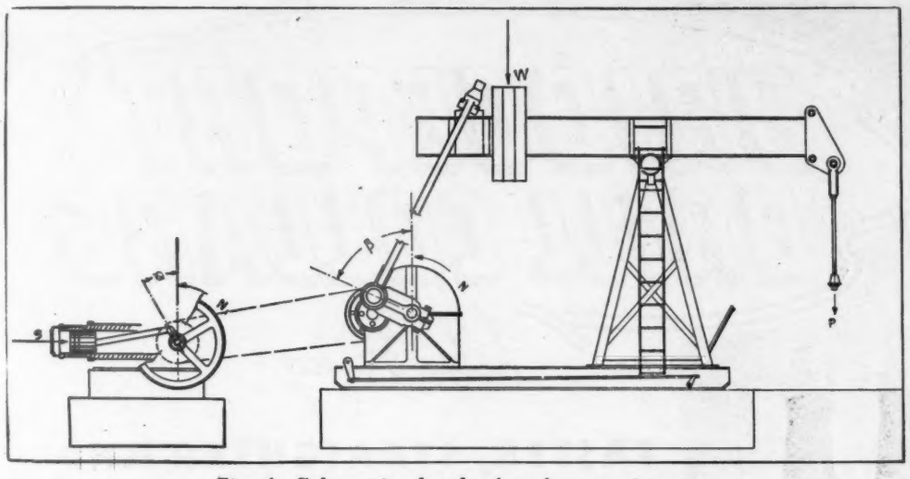

Fig. 4—Schematic sketch of surface equipment

tions occurs at or near the start of the stroke where the effective crank arm is small, it is not the value to be used in making peak torque calculations. It is believed that for the making of peak torque calculations the A.P.I. formula is sufficiently safe.

The peak load as given by the formula based on the dynamic load, assuming simple harmonic

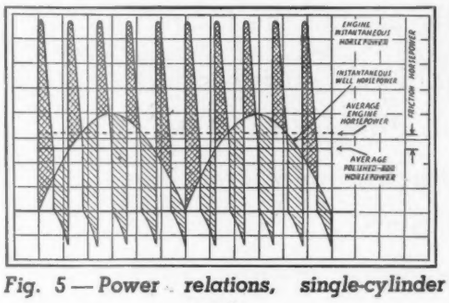

Fig. 5 — Power relations, single-cylinder engine

motion of the crank, and adding the resulting acceleration force to the rod weight is:

$$P = (Wr + Wo)\left[1 + \frac{L}{2\times12\times g}\left(\frac{2\pi N}{60}\right)^2\right]$$

$$= (Wr + Wo)\left[1 + \frac{L\,N^2}{70{,}500}\right] \qquad (12)$$

At a speed of about 13 s.p.m.† the formulas will give the same result.

2. General formulas for peak torque.

To be strictly correct the angle between the crank and pitman should enter into the peak torque calculations. As there are so many factors entering into the peak torque calculations which are more important than this factor it will be neglected. The peak torque will be assumed as equal to the effective polished rod load times the crank radius.

Using the A.P.I. formula, we have:

$$T = [(Wr+Wo)\left(1 + \frac{LN}{5{,}400}\right) - Wc]\frac{L}{2} \qquad (13)$$

The value of Wc is difficult to evaluate. The A.P.I. specifications for rating of pumping units recommend the use of the effective pitman pull as being 40 per cent of the polished rod load or as the actual load less the effective counterbalance. Except for wells operating at slow speeds the counterbalancing of 60 per cent of the load is not believed practical. In the Seminole area the amount of effective counterbalance is practically equal to the rod weight. Instead of the 60 per cent value proposed by the A.P.I. code a 50 per cent value is believed safer. Theoretically, it should be possible to balance at least 50 per cent of the maximum load under any normal conditions, the only exception being the case where the rods are pushed down on the downstroke. For purposes of comparison formulas will be worked out for 50 per cent counterbalance and for balancing the rod weight. This then gives general formulas for peak torque.

1. Case of counterbalance 50 per cent of rod weight using Slonneger formula:

$$T = .5(Wr+Wo)\left(1 + \frac{LN}{5{,}400}\right)\frac{L}{2} \qquad (14)$$

2. Case of counterbalance 50 per cent of rod weight using Standard‡ formula:

$$T = .5(Wr+Wo)\left(1 + \frac{LN^2}{70{,}500}\right)\frac{L}{2} \qquad (15)$$

3. Case of counterbalance of rod weight using Slonneger formula:

$$T = [(Wr+Wo)\left(1 + \frac{LN}{5{,}400}\right) - Wr]\frac{L}{2} \qquad (16)$$

4. Case of counterbalance of rod weight using Standard formula:

$$T = [(Wr+Wo)\left(1 + \frac{LN^2}{70{,}500}\right) - Wr]\frac{L}{2} \qquad (17)$$

3. General formulas for calculating production.

In working out the range of application of a pumping unit, production is the general factor used to select units. The above formulas will, therefore, be expressed in terms of the production. The general formula for production is given by:

$$Q = eCNL \qquad (18)$$

‡The Standard formula is the same as Equation 12, and is based on simple harmonic motion of the crank.

Where $C = .1166\,d^2$ (19)

or $NL = \frac{Q}{eC}$ (20)

Substituting the value given in Equation 20 in Equations 14-17 inclusive, we have:

$$T = .5(Wr+Wo)\left(1 + \frac{Q}{5{,}400\,eC}\right)\frac{L}{2} \qquad (21)$$

$$T = .5(Wr+Wo)\left(1 + \frac{NQ}{70{,}500\,eC}\right)\frac{L}{2} \qquad (22)$$

$$T = [(Wr+Wo)\left(1 + \frac{Q}{5{,}400\,eC}\right) - Wr]\frac{L}{2} \qquad (23)$$

$$T = [(Wr+Wo)\left(1 + \frac{NQ}{70{,}500\,eC}\right) - Wr]\frac{L}{2} \qquad (24)$$

Solving these equations for Q we have:

Case No. 1—50 per cent maximum load counterbalanced—A.P.I. formula:

$$Q = \left(\frac{4T}{L(Wo+Wr)} - 1\right)5{,}400\,eC \qquad (25)$$

Case No. 2—50 per cent maximum load counterbalanced—Standard formula:

$$Q = \left(\frac{4T}{L(Wo+Wr)} - 1\right)\frac{70{,}500\,eC}{N} \qquad (26)$$

Case No. 3—Rod weight counterbalanced—A.P.I. formula:

$$Q = \left(\frac{2T - LWo}{L(Wo+Wr)}\right)5{,}400\,eC \qquad (27)$$

Case No. 4—Rod weight counterbalanced—Standard formula:

$$Q = \left(\frac{2T - LWo}{L(Wo+Wr)}\right)\frac{70{,}500\,eC}{N} \qquad (28)$$

C. Proper Ratio of Speed to Stroke

From the equations given for peak torque it can be seen that for a given polished rod travel

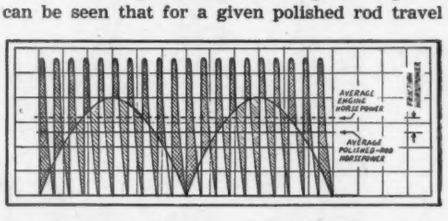

Fig. 6—Power relations, multicylinder engine

the peak torque increases with L. The question then arises as to whether there is some definite ratio of speed and length of stroke to get the most out of a given gear box. An examination of Equation 25 shows that for a given polished rod travel (or production) that the peak torque required of the gear box is less as the length of stroke is reduced. If the A.P.I. formula for loads

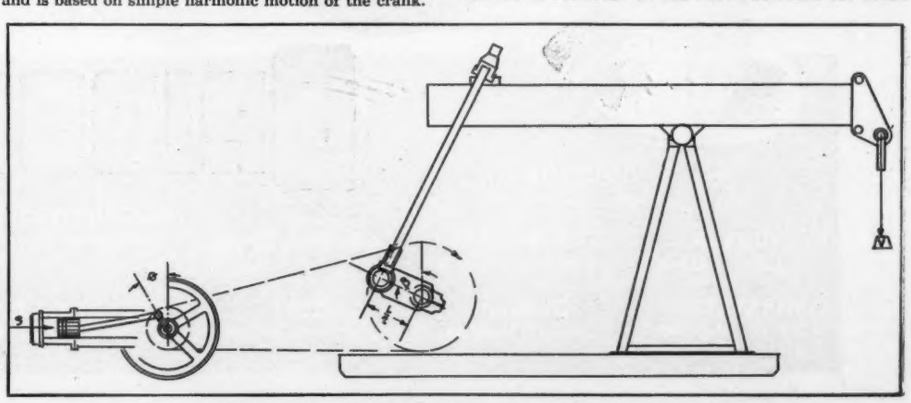

Fig. 7—Schematic sketch of unit with fixed weight

†Strokes per minute.

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is used, it can be seen from the equations that for a given production or polished rod travel (LN) that the torque requirements are directly proportional to the crank radius. Rewriting Equation 14 and introducing the production, we have:

$$T = .5(Wr+Wo)\ (1 + \frac{Q}{5{,}400\ eC})\ \frac{L}{2} \qquad (29)$$

In this equation it is implied that the product LN is kept a constant.

This equation shows that the crank or length of stroke should be made as small as possible in order to get as much as possible out of a gear box or in order to be able to use as small a gear box as possible on a given well.

In this case where the Standard formula is used to calculate the peak load the torque Equation 15 can be rewritten as follows:

$$T = .5(Wr+Wo)\ (\frac{L}{2} + \frac{Q^2}{70{,}500\ e^2C^2}) \qquad (30)$$

This equation again shows that for a given polished rod travel or given production that the peak torque requirements go up as the length of stroke or crank throw is increased. In this case. the length of stroke does not enter as a direct factor. It does, however, account for a major part of the peak torque under most conditions and it can be seen that in either case it is the controlling factor.

Summarized briefly, this means that a short fast cycle requires a smaller reduction unit for a given production. In the case of a standard front or a chain unit of a given capacity a short fast cycle would reduce the effective belt or chain load.

While the above formulas have been worked through for only the case where 50 per cent of the maximum load is counterbalanced, it is obvious that the same general conclusions would result from any other amount of counterbalance.

D. Application of Formulas for the Selection of Standard Sizes

In the determination of unit sizes the question arises as to what particular sizes should be selected to prevent overlapping of range of application. An examination of Equation 25 shows that for a given rod load and production a given ratio of $\frac{T}{L}$ is required. This is in accordance with the discussion of the previous section and also indicates that careful consideration must be given to the ratio of peak torque and crank radius of the unit. In this case, it is seen that, for example, a 150,000 inch-pound box with a 25-inch crank would do as much as a 180,000 inch-pound box with a 30-inch crank. It must be remembered, however, that it has been implied in the writing of Equation 25 that the product NL, or speed times stroke, is a fixed value. Considering the problem on this basis we see that a 150,000 inch-pound gear box operating on a well with a 24-50-inch cycle will produce as much fluid as a 180,000 inch pound box on a well with a 20-60-inch cycle.

The production can, however, be varied by a change in the pump size. If, therefore, we assume that the speed remains constant and the plunger size is varied to take care of changes in production, the $\frac{T}{L}$ ratio would remain constant, neglecting any change in Wo. From Equation 25 it can be seen that if the term $\frac{4T}{L(Wr+Wo)}$ is of the order of 10 then a line of units should be designed with values of $\frac{T}{L}$ in proportion to the production. If the term $\frac{4T}{L(Wr+Wo)}$ has a value near 1, then the series of units will have a smaller variation and it may not be a linear variation. Actually, the weight of rods and fluid must be considered. From Equation 25 it is obvious that a lower value of $(Wo+Wr)$ will require a smaller gear unit. As these factors are all interconnected actual values must be considered in working out a series of units.

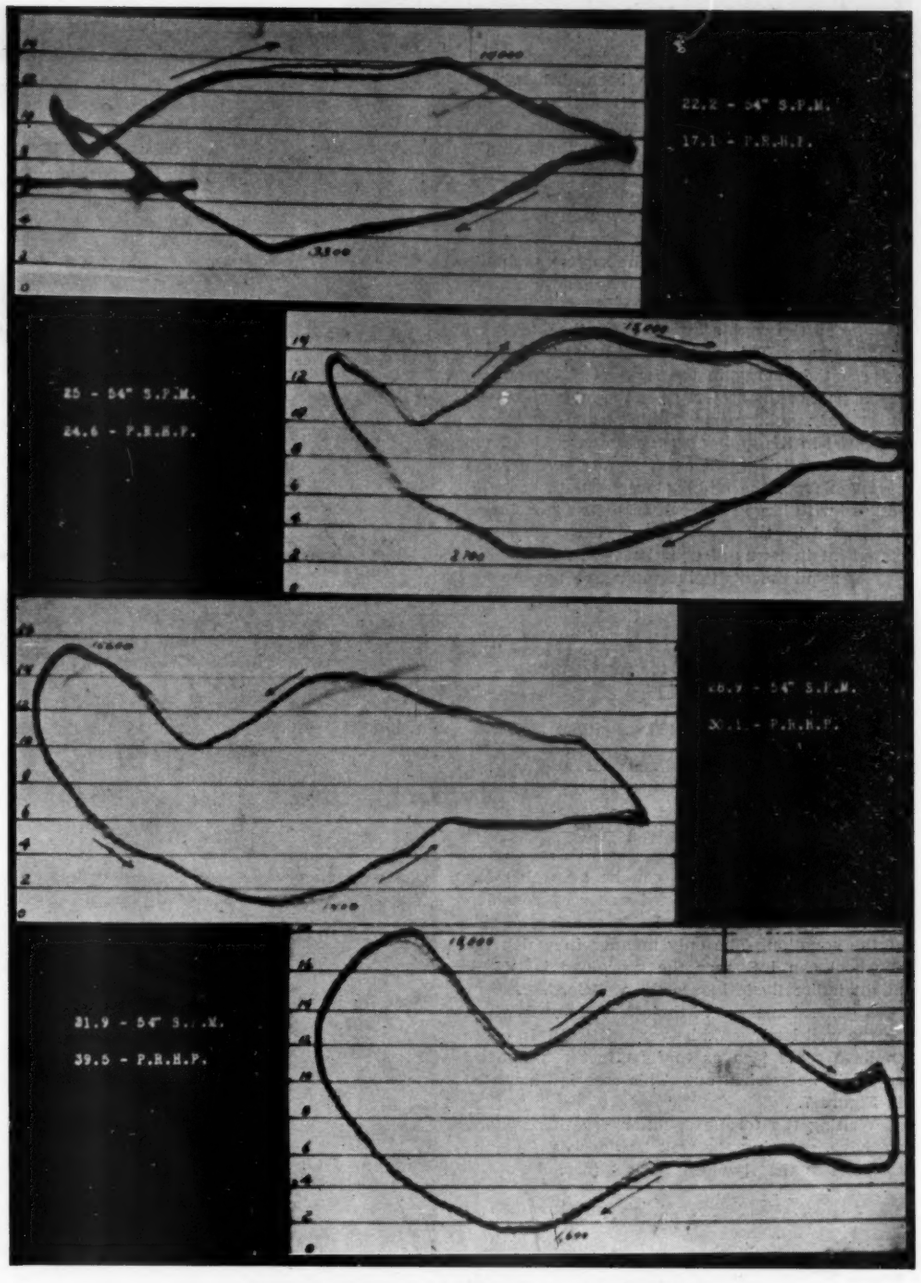


Fig. 8—Dynamometer cards, 3,990-foot well
S.P.M.—strokes per minute. P.R.H.P.—polished-rod horsepower

E. Effect of Prime Mover on Torque Rating

The application of units up to this point has considered only the well or polished rod load less counterbalance requirements. Before going into some specific examples the question as to the possible effects of the prime mover will be considered. In order to better illustrate the various factors involved, the unit and driving elements as shown in Figure 4 will be used for making the comparison. In this case, S is the net piston force, I, the moment of inertia of the engine flywheel, N_1, the engine speed, and, n, the ratio of engine to well speed.

In the discussion which follows it is to be remembered that the forces, P and S are not constant but vary over the well cycle. If an analytical expression is desired for P and S they can be determined from indicator diagrams and dynamometer cards and expressed by a Fourier series in the form:

$$S = Ao + A_1\cos\theta + A_2\cos 2\theta + A_3\cos 3\theta + \ldots + An\cos n\theta + B_1\sin\theta + B_2\sin 2\theta + B_3\sin 3\theta + \ldots + Bn\cos n\theta \qquad (31)$$

and

$$P = ao + a_1\cos\beta + a_2\cos 2\beta + a_3\cos 3\beta + \ldots + an\cos n\beta + b_1\sin\beta + b_2\sin 2\beta + b_3\sin 3\beta + \ldots + bn\sin n\beta \qquad (32)$$

Where $\theta = \frac{2\pi N_1}{60}t$ and $\beta = \frac{\theta}{n}$, t being time.

From these expressions it can be seen that

P and S are functions of time and are cyclic in form.

In order to show what takes place over a well cycle Figures 5 and 6 have been drawn. The dotted curve shows the net well requirement and the solid line represents the engine output over the cycle. Figure 5 has been drawn for a single-cylinder two-cycle engine and Figure 6 for two-cylinder two-cycle or a four-cylinder four-cycle engine. Where the area under the engine curve is above the well requirement curve the engine is putting more energy into the system than the well requires. It is, therefore, necessary to store this energy in the system so that it will be available when the engine input is less than the well requirements. This energy can be stored either as potential energy in the form of strain energy in the part of the system or in the form of kinetic energy of moving parts. Little strain energy can be stored in the system so that practically all the excess or deficiency in energy must be stored in or taken from the moving parts. In the case of engines with large flywheels this energy exchange is handled by the flywheels. Writing the above statement in terms of equations, we have, reducing the requirements to instantaneous horsepower, that:

Instantaneous horsepower output of engine = instantaneous horsepower requirements of well — instantaneous energy stored in flywheel.

$$\text{or} \quad \frac{Sr\cos\theta}{33{,}000\times12}\,2\pi N_1 = \frac{(P-Wc)}{12\times33{,}000} \times \frac{L}{2}(2\pi N)\sin\beta + \frac{I\alpha}{12\times33{,}000}\times 2\pi N_1 \quad (33)$$

$$\text{or} \quad nSr\sin\theta - nI\alpha = (P-Wc)\frac{L}{2}\sin\frac{\theta}{n} \quad (34)$$

From this equation it can be seen that the gear loads can be determined either by considering the engine and flywheel side or the well side of the equation. The only manner in which the flywheel can influence the gear load is that it might indirectly influence the well load, P.

A general analysis of the effect of the flywheel on the well load would be very difficult. In order to have some idea as to its effect a simplified case will be worked out. This case is illustrated in Figure 7.

Writing the torque equation for this system, we have, equating the well torque to the engine torque less the flywheel torque, that:

$$P\times\frac{L}{2}\sin\beta = nSr\cos\theta - nI\frac{d^2\theta}{dt^2} \quad (35)$$

Where $$P = V + \frac{V}{g}A_v \quad (36)$$

Assuming simple harmonic motion of the crankshaft we have that:

$$A_v = \frac{L}{2}\cos\beta\frac{d^2\beta}{dt^2} = -\frac{L}{2n}\cos\frac{\theta}{n}\times\frac{d^2\theta}{dt^2}$$

$$\text{or} \quad P = [V + \frac{V}{g}(\frac{L}{2n}\cos\frac{\theta}{n})\frac{d^2\theta}{dt^2}] \quad (37)$$

$$\text{or} \quad [V + \frac{V}{g}(-\frac{L}{2n}\cos\frac{\theta}{n})\frac{d^2\theta}{dt^2}]\frac{L}{2}\sin\beta = nSr\cos\theta - nI\frac{d^2\theta}{dt^2} \quad (38)$$

$$\frac{d^2\theta}{dt^2}[nI + V + \frac{V}{g}(-\frac{L}{2n}\cos\frac{\theta}{n})] = nSr\cos\theta \quad (39)$$

Where $S = Ao + A_1\cos\theta + \ldots + An\cos n\theta + B_1\sin\theta + \ldots + Bn\sin n\theta$

$$\text{or} \quad \frac{d^2\theta}{dt^2} = \frac{nSr\cos\theta}{[nI + V + \frac{V}{g}(-\frac{L}{2n}\cos\frac{\theta}{n})]} \quad (40)$$

From Equation 37 it is obvious that P will depend on the value of $\frac{d^2\theta}{dt^2}$ since $\cos\frac{\theta}{n}$ is a cyclical function and will vary between 0 and 1. The smaller the value $\frac{d^2\theta}{dt^2}$ the smaller the well load and therefore the torque on the gear. From Equation 40 it is seen that the larger the value of nI for a given engine (value of S) and the weight, V, the lower the value of $\frac{d^2\theta}{dt^2}$ and, therefore, the rod load, P, and the peak torque.

For the simple case of concentrated load hung on the beam it can be seen without solving the above equations that the maximum load is actually lowered by increasing the weight of the flywheel. These equations assume that the engine governor does not work during a cycle, that is, that all engine explosions are the same size. This will be true on an actual engine if the engine is hand throttled or if the coefficient of fluctuation of the engine is within the sensitivity of the governor.

As a further deduction from Equation 40 it is seen that if nI is large compared with V that the $\frac{d^2\theta}{dt^2}$ becomes proportional to a factor divided by I or to the engine coefficient of fluctuation. From this elementary analysis it would appear that engines with the same engine coefficient of fluctuation would operate with equivalent effect on gears.

Actually looking at the problem from the well side it is obvious that with reasonable sizes of flywheels, the prime mover will not affect the gear loading. This does not preclude any variations set up as a result of natural vibrations which may be set up in the system, however.

The argument has frequently been advanced that with an engine with a small flywheel the speed variation that results will result in lower

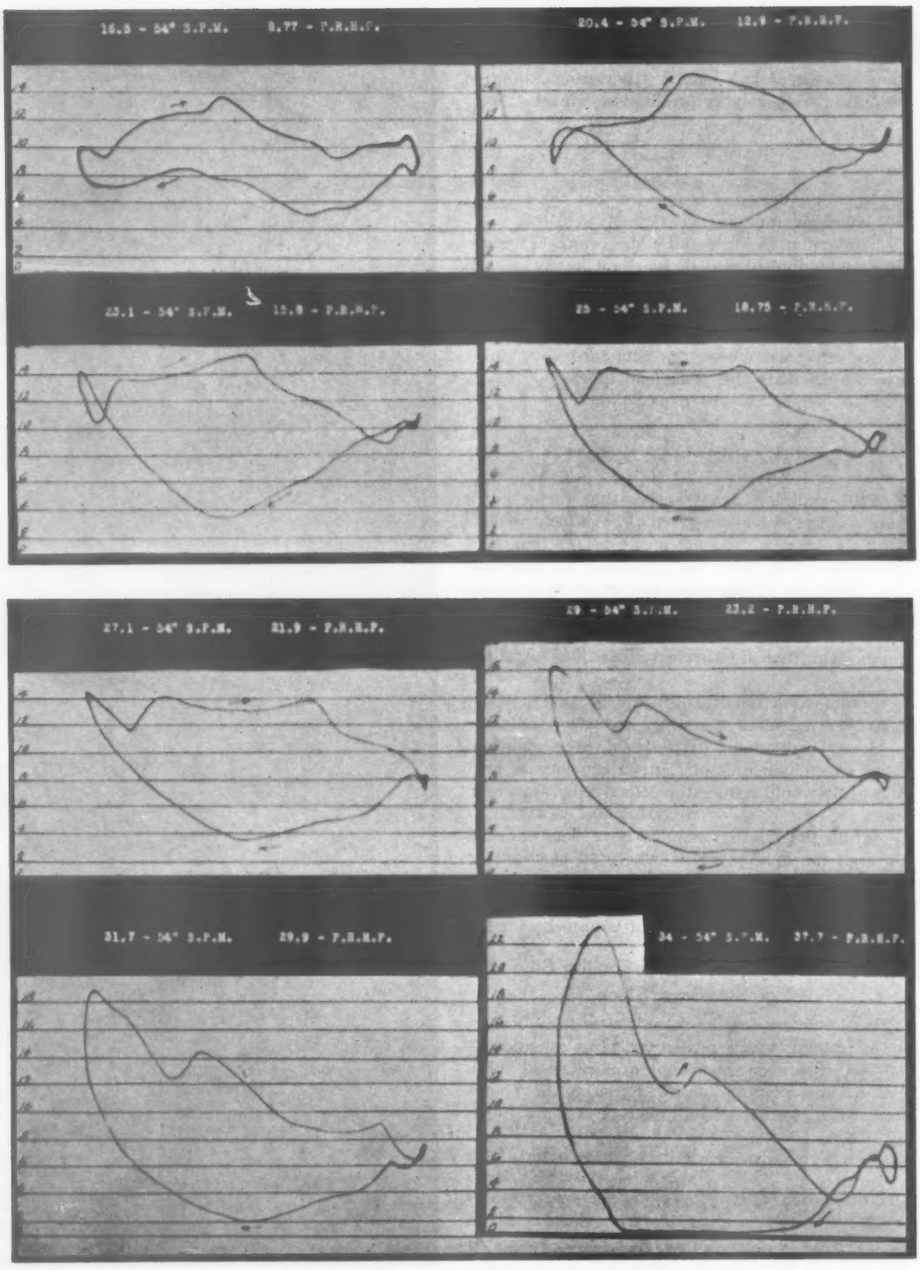
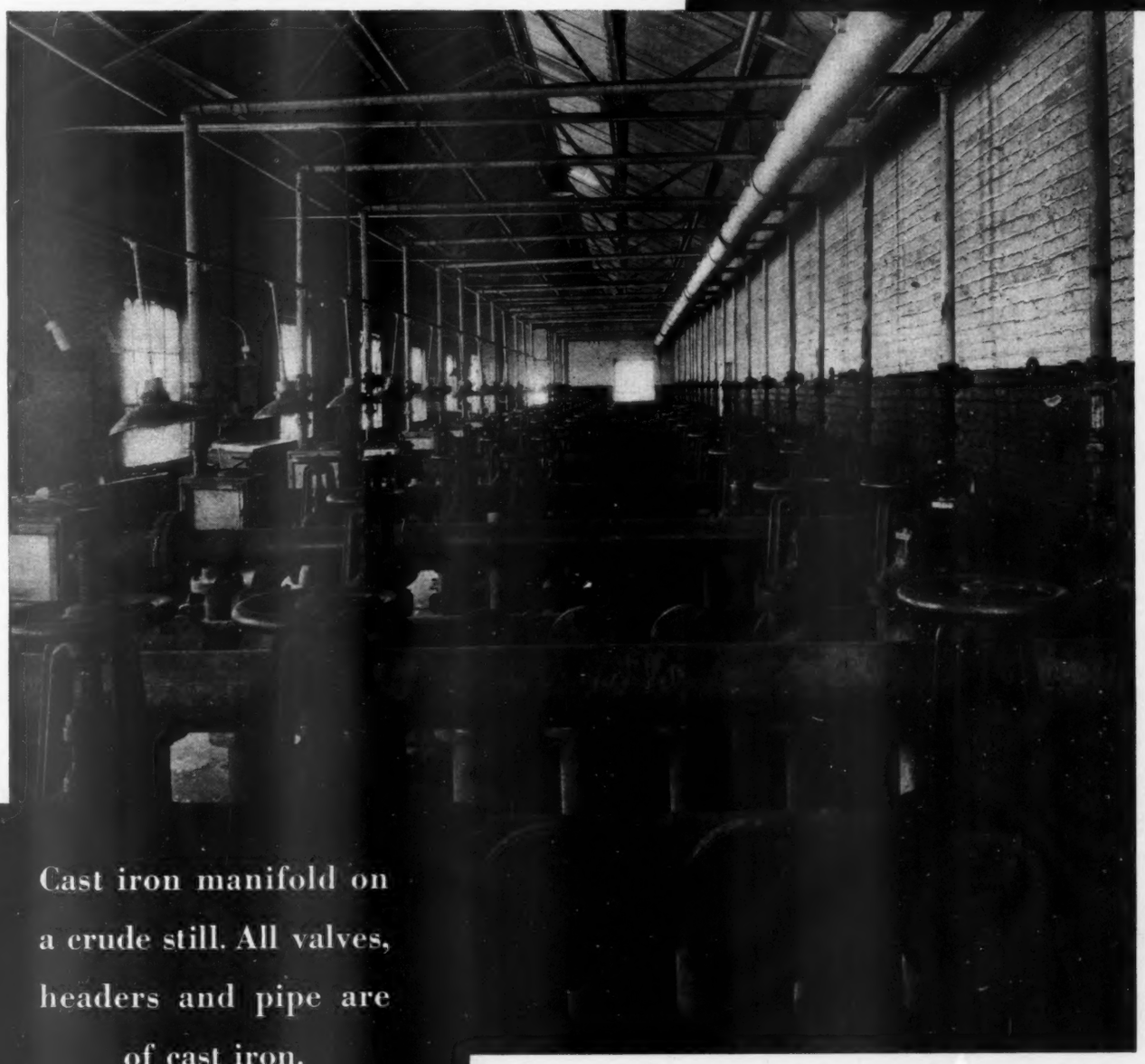


Fig. 9—Dynamometer cards, 3,300-foot well
S.P.M.—strokes per minute. P.R.H.P.—polished-rod horsepower

FOR LOWER MAINTENANCE COST— *CAST IRON PIPE*

THE watchdog of the refinery is the man responsible for keeping down maintenance cost per barrel of crude. He knows that, balancing first-cost against length and dependability of service, pipe cast from good gray iron is the most economical at many points in refinery operation. It is reliably resistant to corrosion under a wide range of conditions. It has a definite and considerable salvage value. Available in bell-and-spigot, plain or threaded end and flanged types, or with bottle-tight mechanical joints for high pressures. Diameters from 1¼ to 84 inches. Address inquiries to The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, 1015 Peoples Gas Building, Chicago.

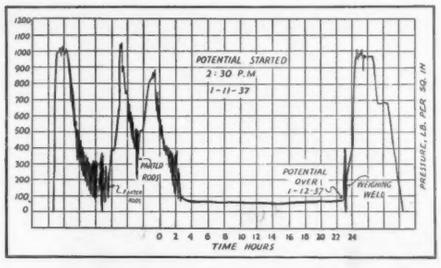


Cast iron manifold on a crude still. All valves, headers and pipe are of cast iron.

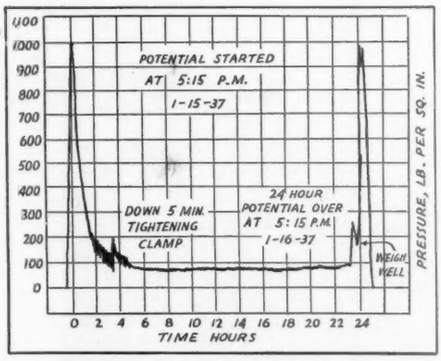
TABLE 1

No.	Hour	Engine speed	Strokes per minute	Oil production	Total fluid	Peak load	Rod hp.	Volume eff. (%)	B.H. pressure	Fluid level	Lift	H yd. hp.	Lift eff. (%)
0	4:30	252	24.0	0		14,300	14.5	...	1,082	3,110	206	1.2	8.3
1	5:30	222	21.2	36.0	42.0	14,500	14.6	97.4					
2	6:30	231	22.0	25-3/4	31-3/4	15,800	18.7	81.5	490	1,415	1,901	8.8	47.0
3	7:30	250	23.8	25-3/4	30-3/4	15,100	20.0	76.0					
4	8:30	230	22.0	28-1/3	33-1/3	16,200	20.3	76.0	267	770	2,548	10.3	50.7
5	9:30	231	22.0	23-1/6	28.2	16,400	19.5	69.6					
6	10:30	237	22.6	23-1/6	27.2	16,400	20.6	67.4	208	600	2,716	10.7	52.0
7	11:30	235	22.4	23-1/6	27.5	16,300	20.0	66.3					
8	12:30	231	22.0	24-1/2	27.5	16,200	19.4	66.3	182	525	2,791	10.5	54.1
9	1:30	230	22.0	23-1/6	26.2	16,000	19.8	64.1					
10	2:30	228	21.7	18.0	21.0	15,900	20.0	52.2	165	476	2,840	10.0	50.0
11	3:30	237	22.6	22.2	25.2	15,700	20.0	63.0					
12	4:30	229	21.8	24.5	27.5	16,000	20.2	66.3	170	490	2,826	11.5	57.0
13	5:30	227	21.6	25-3/4	28-3/4	15,700	19.4	64.1					
14	6:30	231	22.0	23.2	26.2	16,300	19.5	66.3	188	642	2,674	10.5	53.9
15	7:30	228	21.7	24.5	27.5	16,400	19.6	68.5					
16	8:30	229	21.8	23.2	26.2	16,500	20.3	65.2	188	642	2,674	11.4	56.1
17	9:30	229	21.8	27.0	30.0	16,500	19.2	67.5					
18	10:30	228	21.7	23.2	26.2	16,800	19.3	65.2	183	639	2,677	10.5	54.4
19	11:30	226	21.5	24.5	27.5	16,800	19.0	68.5					
20	12:30	229	21.8	20.6	23.6	16,800	20.0	59.8	182	625	2,691	8.7	43.0
21	1:30	230	22.0	19.3	22.3	16,900	18.94	55.4					
22	2:50	224	21.3	23.2	26.2	16,400	16.06	65.2	250	722	2,594	9.8	61.1
23	3:50	221	21.0	23.2	26.2	16,850	16.8	66.3					
24	4:50	225	21.4	20.6	23.6	17,000	17.1	60.9	210	607	2,709	9.2	53.8

maximum loads, thus being easier on the rods and gear unit. As just pointed out it is questionable if this effect exists or is noticeable. If, however, the speed change on the upstroke is sufficient to lower the peak load, the speed increase on the downstroke or during the time the load is decreasing will result in a lower minimum load. As the counterbalance under these conditions will probably be lower the peak torque may still be as high. The torque which the gear must carry is the unbalanced well load.



Bottom-hole pressure at start of potential, 905 pounds per square inch. Average pumped-down pressure, 72.91 pounds per square inch. 36—54-inch s.p.m. Average steady-state production, 75.21 bbls. per hour.



Bottom-hole pressure at start of potential, 1,010 pounds per square inch. Average pumped-down pressure, 83.08 pounds per square inch. 36—54-inch s.p.m. Average steady-state production, 76.8 bbls. per hour.

Fig. 10.—Bottom-hole pressure charts

The curves shown in Figures 5 and 6 show schematically the energy delivered by the prime mover and the well requirements. The double-sectioned area represents the part of the cycle where the energy output exceeds the well requirements and the single-sectioned area represents the part of the cycle where the well requirements exceed the engine output. The flywheels act as an energy reservoir in which to store and from which to obtain energy.

F. Illustrations of Individual Well Performances

It is generally considered that the peak torque is dependent on the peak load. The following examples are illustrations of cases which show that peak load is not necessarily a factor in determining peak torque and that at high operating speeds peak torque may actually be less than at moderate speeds. Figure 8 shows dynamometer cards taken on a well pumping from a depth of 3,990 feet. Static bottom-hole pressure was 485 pounds per square inch and bottom-hole pressure at production rate of 600 bbls. per day and average speed of 29.6 s.p.m. was 420 pounds per square inch. In this case it is seen that the peak torque occurred at a speed of about 25 s.p.m. At 31.9 s.p.m. the peak torque is approximately the same or possibly less than at 25 s.p.m. and at 29 s.p.m. the peak torque is about equal to that at 22 s.p.m. In each of these cases the well was pumped for over one hour at each speed before the dynamometer cards were taken and in each case the well had reached a steady state condition. These dynamometer cards at the higher speeds show an indication of fluid pound. Bottom-hole pressure data, however, showed that this pound was not due to lack of fluid but was a gas pound. A complete analysis of pumping wells generally requires bottom-hole pressure data as well as pumping data.

Figure 9 gives data on a 3,300-foot well. The bottom-hole pressure chart taken on this pumping test is shown on Figure 10. This chart shows that the well was pumped down. The peak torque occurred between 20.4 and 23.1 s.p.m. on this well. At higher speeds the peak torque was less than at these speeds except perhaps in the case when the well was operating at 34 s.p.m. The peak torque at 16.5 s.p.m. is seen to be apparently higher than at 29 s.p.m. and 31.7 s.p.m. Because of the fact that the peak load at higher speeds occurs at or very near the start of the upstroke, the peak load under these conditions does not necessarily have any relation to the peak torque. For these reasons it is not an accurate value to be used in making peak torque calculations but will in every case give conservative values.

Figures 11 and 12 and Table 1 list complete data on pumping tests taken on a 3,300-foot well. These data show that the load and horsepower requirements vary with the fluid level. It will be noted from Figure 12 that the peak load at the start of the test was on the order of 14,000 pounds whereas at the end of the test it was approximately 17,000 pounds. This difference in peak load is due to the difference in lift.

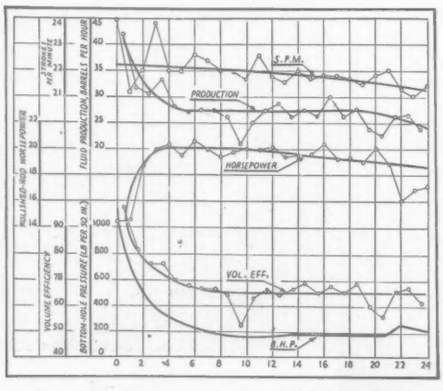


Fig. 11—Pumping test, 3,300-foot well

Vol. eff = volume efficiency.
B.H.P. = bottom-hole pressure

The many factors which affect peak load and also the relation between load and crank angle determine to a large extent the torque which will be transmitted. In general, the use of peak load in the figuring of peak torque will give values which are definitely conservative.

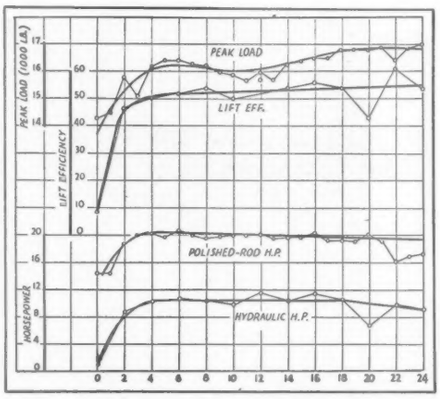


Fig. 12—Pumping test, 3,300-foot well

G. Torsional Vibrations in Geared Systems

1. Introduction.

The A.P.I. specifications for rating of pumping machines definitely state that the rating and limiting of loads as given by the A.P.I. formula applies only when there is an absence of torsional vibration. A recent investigation of the torque transmitted through reduction gears on pumping wells indicated the presence of torsional vibration in this type service. The theoretical investigation, which follows, was made on this subject and showed that torsional vibration in pumping wells at certain speeds are actually present in the systems used at the present time.

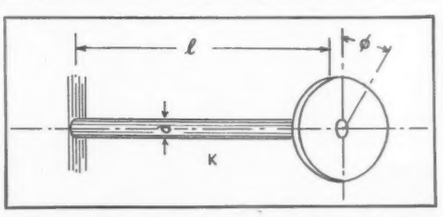


Fig. 13—Shaft fixed at one end

2. Torsional vibration of a single-mass system.

The simplest case of a torsional vibration will be considered first. (See Timoshenko, "Vibration Problems in Engineering," for general discussion on vibration.) The developed formulas for this

(Continued on Page 122)

to 3500 POUNDS

At Tepetate—CLARK "Angles" prove they've "got what it takes" for Pressure Maintenance at highest pressures

Two years ago, the Continental Oil Company began operating the World's highest pressure plant for gas conservation and pressure maintenance — in the Tepetate Field of Louisiana.

The plant was equipped with four CLARK 300 H.P. "Super-2-Angle" Compressors, which were capable of returning to the formation 10,000,000 cu. ft. of gas per day, at pressures up to 4,000 pounds. In fact, these units have been operated with entire satisfaction,—on a test,—up to 4,600 pounds. Prior to that time no attempt had been made to return gas to a producing zone at above 3,000 pounds.

During their two years of continuous operation at pressures ranging from 2,600 to 3,500 pounds, the four CLARK "Angles" have given highly satisfactory service. As a result of their excellent performance, two more 300 H.P. units were soon added to increase the capacity of the plant; and recently a further addition of two 5-cylinder 500 H.P. CLARK "Angles" was made. The plant now contains 8 CLARK "Angle" machines, totaling 2,800 H.P.

The Continental Oil Company is probably the outstanding pioneer in pressure maintenance. It is estimated that Pressure Maintenance, at Tepetate, will increase the ultimate oil recovery of the pool by at least 40%. The plant investment required to accomplish this increase is estimated to represent only 5% of the value of the added production.

Write us for booklet giving the history of Pressure Maintenance and its results to date, and the outstanding record of CLARK Compressors in this pioneer field.

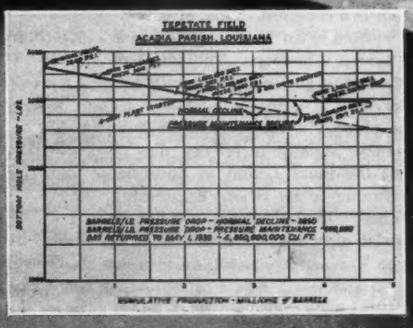
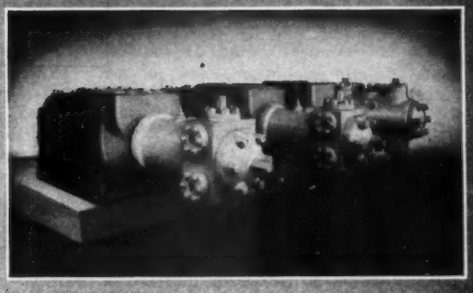
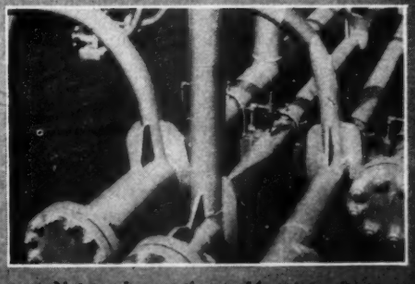


Chart shows how graph of normal decline in pressure "flattened out", when Pressure Maintenance plant was placed in operation



CLARK high-pressure cylinder used for second stage of compression. Barrel and head are forged from single steel billet



Note, above, the weld-reinforcing with gusset plates, for handling the pressures from 2,600 to 4,600 pounds

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type of system can be applied directly to a shaft with two masses, as will be pointed out later.

The following symbols will be used:

I = moment of inertia of mass (in.-lb.-sec.^{2})
T = torque (in.-lb.)
ϕ = angle of twist (radians)
k = torque necessary to produce an angle of twist of 1 radian (in.-lb./radian)
l = length of shaft (inches)
E_s = modulus of elasticity in shear or coefficient of rigidity (pounds per square inch)
P = period of vibration

By definition $T = k\phi$ (41)

From formulas for torsional deformation of a circular shaft:

$$T = \frac{E_s I_s}{l}\phi \quad (42)$$

Where I_s is the moment of inertia of the shaft (in.^{4}). By inspection, therefore:

$$k = \frac{E_s I_s}{l} \quad (43)$$

For the case of a simple vibrating system, such as shown in Figure 13, we know that the energy stored in the system is a constant. This, of course, assumes an ideal system with no energy dissipation and without forced vibrations. The effect of friction, forced vibrations and mass of shaft will be considered later.

Energy can be stored in the system in only two manners, namely, as kinetic energy due to the acceleration of the mass I, and as potential energy in the shaft due to its twist. Expressing the fact that the energy in the system is constant and that it can exist only in two forms, mathematically, we have:

$$I\frac{d^2\phi}{dt^2} + k\phi = 0 \quad (44)$$

Where I is the moment of inertia of the mass on the end of the shaft. Dividing by I we have:

$$\frac{d^2\phi}{dt^2} + \frac{k}{I}\phi = 0 \quad (45)$$

Let $$\frac{k}{I} = p^2 \quad (46)$$

Then $$\frac{d^2\phi}{dt^2} + p^2\phi = 0 \quad (47)$$

The solution of this differential equation has the general form:

$$\phi = A\cos pt - B\sin pt \quad (48)$$

Where A and B are arbitrary constants depending on the particular boundary conditions.

From Equation 48 it can be seen that the period of the vibration will be:

$$P = \frac{2\pi}{p} = 2\pi\sqrt{\frac{I}{k}} \quad (49)$$

The natural frequency, f, is $\frac{1}{P}$ or

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{I}} = \frac{1}{2\pi}\sqrt{\frac{E_s I_s}{I}} \quad (50)$$

In case the shaft has a variable diameter the equivalent, k, for a uniform diameter shaft can be calculated and used in the above formula.

3. Torsional vibration of a two-mass system.

For the case of a system with two masses, as shown in Figure 14, the above relations can be directly applied provided the shaft connecting the two masses is of uniform or nearly uniform size. If such a system is set to vibrating naturally by giving the discs an opposite torque and releasing them, it will be found that at some section m-n there will be no movement of the shaft. While disc No. 1 is moving in one direction, disc No. 2 will be moving in the other in such a manner that the energy in the system remains constant. The frequency of vibration of each disc must necessarily be the same to have this energy relation exist. The nodal point m-n then adjusts itself in such a manner that the effective shaft length for each disc makes their frequencies equal. If this relation is fulfilled, we then have,

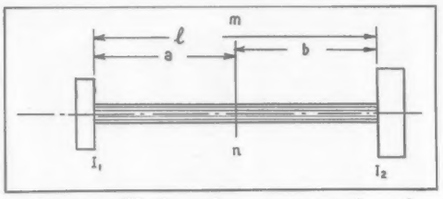

Fig. 14—Shaft with mass at each end

using Equation 50 and considering each disc a separate system:

$$\frac{1}{2\pi}\sqrt{\frac{E_s I_s}{aI_1}} = \frac{1}{2\pi}\sqrt{\frac{E_s I_s}{bI_2}} \quad (51)$$

Or $$aI_1 = bI_2 \quad (52)$$

Since $$a + b = l \quad (53)$$

We then have $$a = \frac{I_2 l}{I_1 + I_2} \quad (54)$$

and $$b = \frac{I_1 l}{I_1 + I_2} \quad (55)$$

The natural frequency of this system is then given by

$$f = \frac{1}{2\pi}\sqrt{\frac{E_s I_s (I_1 + I_2)}{I_2 I_1}} \quad (56)$$

4. Forced vibrations.

In the above discussion only free vibrations were discussed. These are vibrations of an elastic system when disturbed from its equilibrium position by internal forces. When an external periodic disturbing force is applied to the system, forced vibrations of the system will be produced. These forced vibrations will be in phase with the disturbing force. In case the frequency of the disturbing force equals the frequency of the natural or free vibration of the system a condition of resonance occurs and the frequency of the forced vibration is called the critical frequency. For this case the amplitude would become infinite if there were no damping present.

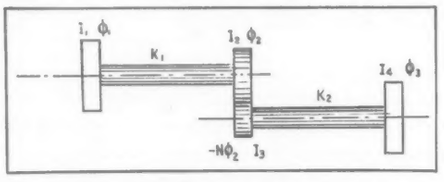

Fig. 15—Single reduction-gear train

In the case of damping, which is always present, the amplitude will assume some value larger than the equivalent static amplitude. In case of insufficient damping the amplitude may become infinite. In case the normal speed is slightly different than the critical, a similar condition may exist. A complete discussion of this would become quite involved and since it is treated in detail in treatises on the theory of vibrations it will not be further discussed here.

In case the moment of inertia of the shaft is large compared with the mass it is necessary to make a correction. It has been shown that as an approximation that if the mass at the end of the shaft is increased by about one-third the mass of the shaft, the correct natural frequency will be obtained. As the shaft mass is small in comparison with the mass of the pulleys or counterbalance it will be neglected in the following discussion.

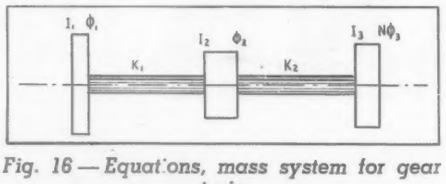

Fig. 16 — Equations, mass system for gear train

5. Simple-geared system.

Figure 15 shows schematically the geared system in a reduction unit. Any of three conditions can exist in such a system. A critical condition might be reached in either of the shaft systems, which could be calculated by above formulas, or the entire system might have a critical or several critical speeds. The system shown in Figure 15 can be represented by the equivalent system shown in Figure 16 if the following conditions are fulfilled:

$$I_2 = i_2 + N^2 i_2 \quad (57)$$

$$\phi'_2 = N\phi_2 \quad (58)$$

$$I_3 = N^2 i_4 \quad (59)$$

and $$k'_2 N^2 = k_2 \quad (60)$$

where N is speed ratio of gears.

For the system shown in Figure 15 we have that the kinetic energy, U, in the system is:

$$U = \frac{I_1}{2}\left(\frac{d\phi_1}{dt}\right)^2 + \frac{i_2}{2}\left(\frac{d\phi_2}{dt}\right)^2 + \frac{i_3}{2}\left(\frac{-Nd\phi_2}{dt}\right)^2 \quad \ldots + \frac{i_4}{2}\left(\frac{d\phi'_3}{dt}\right)^2 \quad (61)$$

The potential energy, V, of the system is given by:

$$V = \frac{1}{2}k_1(\phi_1 + \phi_2)^2 + \frac{1}{2}k_2'(\phi_3' - N\phi_1)^2 \quad (62)$$

For the system shown in Figure 16 these equations reduce as follows:

$$U = \frac{I_1}{2}\left(\frac{d\phi_1}{dt}\right)^2 + \frac{I_2}{2}\left(\frac{d\phi_2}{dt}\right)^2 + \frac{I_3}{2}\left(\frac{d\phi_3}{dt}\right)^2 \quad (63)$$

$$V = \frac{1}{2}k_1(\phi_1 + \phi_2)^2 + \frac{1}{2}k_2(\phi_2 - \phi_3)^2 \quad (64)$$

Substituting these in the Lagrangian equation:

$$\frac{d}{dt}\left(\frac{\partial U}{\partial qi}\right) - \frac{\partial U}{\partial qi} + \frac{\partial V}{\partial qi} = 0 \quad (65)$$

We have:

$$I_1\frac{d^2\phi_1}{dt^2} + k_1(\phi_1 - \phi_2) = 0 \quad (66)$$

$$I_2\frac{d^2\phi_2}{dt^2} + k_2(\phi_2 - \phi_3) - k_1(\phi_1 - \phi_2) = 0 \quad (67)$$

$$I_3\frac{d^2\phi_3}{dt^2} - k_2(\phi_2 - \phi_3) = 0 \quad (68)$$

Adding these we get:

$$I_1\frac{d^2\phi_1}{dt^2} + I_2\frac{d^2\phi_2}{dt^2} + I_3\frac{d^2\phi_3}{dt^2} = 0 \quad (69)$$

The solution to this differential equation can be obtained by assuming a solution in the form:

$$\phi_1 = \lambda_1 \mathrm{Cos}\,(pt + \alpha) \quad (70)$$

$$\phi_2 = \lambda_2 \mathrm{Cos}\,(pt + \alpha) \quad (71)$$

$$\phi_3 = \lambda_3 \mathrm{Cos}\,(pt + \alpha) \quad (72)$$

where λ_1, λ_2 and λ_3 are arbitrary constants.

Substituting these values in Equation 69, we find:

$$I_1\lambda_1 p^2 - k_1(\lambda_1 - \lambda_2) = 0 \quad (73)$$

$$I_2\lambda_2 p^2 + k_2(\lambda_1 - \lambda_3) - k_2(\lambda_2 - \lambda_3) = 0 \quad (74)$$

$$I_3\lambda_3 p^2 + k_2(\lambda_2 - \lambda_3) = 0 \quad (75)$$

Adding these equations we obtain:

$$I_1\lambda_1 + I_2\lambda_2 + I_3\lambda_3 = 0 \quad (76)$$

(Continued on Next Page)

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Baroid—Muds weighted with **Baroid** have demonstrated their efficiency in holding caving formations in place.

Baroid—Muds can be made up to high weights for the control of heaving or disintegrating shale.

Stabilite—The improved chemical thinner—maintains workable viscosities even though highly weighted muds are used in shale areas.

Stabilite—Frees entrained gas and reduces viscosity.

Baroid—Pumpable muds weighing as much as 145 lbs. per cubic foot can be made with **Baroid**.

Aquagel—Helps prevent the filtration of water into formations.

Stabilite—Often prevents discarding cement-cut mud by reducing viscosity and restoring wall-building properties.

Aquagel—Wells drilled in with straight **Aquagel** water mud in low pressure areas, swab on production and clean up quicker because the thin, impervious mud cake is very easy to remove.

Baroid—A combination of **Baroid** and **Aquagel** provides the ideal drilling fluid for pressure areas.

Stabilite—Provides safety by keeping mud free of gas, thereby maintaining weight required.

Stocks carried and service engineers available in all active oil fields. Look for this trade mark under "Oil Well Drilling Mud" in your classified telephone directory for our nearest service engineer and distributor.

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From Equations 73 and 75 we find:

$$\lambda_1 = -\frac{k_1 \lambda_2}{I_1 p^2 - k_1} \quad (77)$$

$$\lambda_2 = -\frac{k_2 \lambda_2}{I_2 p^2 - k_2} \quad (78)$$

Substituting 77 and 78 in 76 and simplifying, we have:

$$\frac{I_1 I_2 I_3}{k_1 k_2} p^4 - \left(\frac{I_1 I_3 + I_1 I_3}{k_1} + \frac{I_2 I_3 + I_1 I_3}{k_2}\right) p^2 \ldots + (I_1 + I_2 + I_3) = 0 \quad (79)$$

Dividing this equation by the coefficient of p^4 we have:

$$p^4 - Ap^2 + B = 0 \quad (80)$$

Where

$$A = \frac{k_2}{I_2}\left(\frac{I_2}{I_3} + 1\right) + \frac{k_1}{I_3}\left(\frac{I_3}{I_1} + 1\right) \quad (81)$$

$$B = \left(\frac{I_1 + I_2 + I_3}{I_1 I_2 I_3}\right) k_1 k_2 \quad (82)$$

$$p^2 = \frac{+A \pm \sqrt{A^2 - 4B}}{2} \quad (83)$$

$$p = \pm \sqrt{\frac{A \pm \sqrt{A^2 - 4B}}{2}} \quad (84)$$

$$p = (\sqrt{A}) \pm \sqrt{\frac{1 \pm \sqrt{1 - 4B/A^2}}{2}} \quad (85)$$

Substituting in Equations 81 and 82 the constants of the original system as given in Equations 57, 58, 59 and 60, we have:

$$A = \frac{k_2' N^2}{(i_2 + N^2 i_3)}\left[\frac{(i_2 + N^2 i_3)}{N^2 i_4} + 1\right] + \frac{k_1}{(i_2 + N^2 i_3)} \ldots \left[\frac{i_2 + N^2 i_2}{I_1} + 1\right] \quad (86)$$

$$B = \frac{[I_1 + (i_2 + N^2 i_3) + N^2 i_4]\, k_1 (k_2' N^2)}{I_1 (i_2 + N^2 i_3)(N^2 i_4)} \quad (87)$$

From the nature of Equations 86 and 87 it is seen that any numerical calculations are easier made by finding the constants of the equivalent system as determined by Equations 57, 58, 59 and 60 and substituting them in Equations 81 and 82.

For a practical solution of these equations certain approximations as outlined below can be made and quite simple solutions will be obtained. These solutions are sufficiently accurate for any practical calculations and do not require the tedious and accurate calculations which must be used to get a solution.

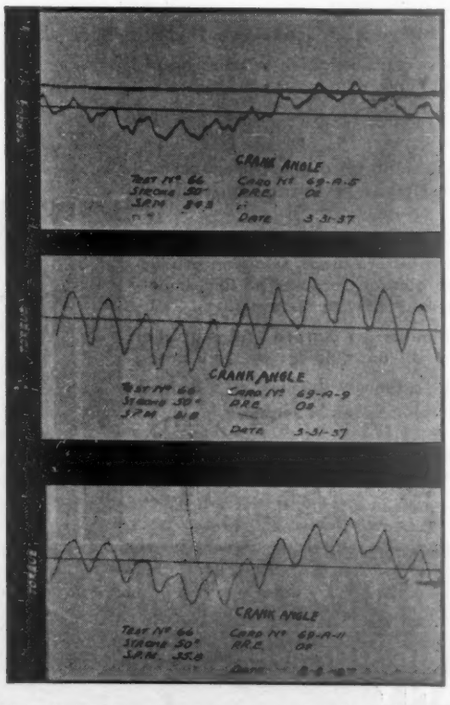

Fig. 17—Torque in gear unit. Single-cylinder engine. Rotary weights with zero counterbalance effect. Well not connected

Equation 83 can be written in the following form:

$$p^2 = \frac{+A \pm \sqrt{A^2 - 4B}}{2} = \frac{+A(1 \pm \sqrt{1 - 4B/A^2}}{2}$$

If $4B/A^2$ is small, then

$$\sqrt{1 - \frac{4B}{A^2}} = 1 - \frac{2B}{A^2} \quad (88)$$

Then $$p^2 = \frac{A(1 \pm 2B/A^2)}{2} = A\left(1 \pm \frac{B}{A^2}\right)$$

or $$p^2 = \frac{B}{A^2} A \quad (89)$$

Solving for p we have:

$$p = \sqrt{A - \frac{A}{B}} \quad (90)$$

or $$p = \sqrt{\frac{B}{A}} \quad (91)$$

If A is large in magnitude and is of comparable magnitude with B, the solution of p of Equation 90 can be further simplified because $\frac{B}{A^2}$ will be small compared with 1 and the solution shown in Equation 90 will become:

$$p = \sqrt{A} \quad (92)$$

As the conditions outlined above are met with reasonable accuracy, Equations 91 and 92 can be used to calculate the natural frequency which in cycles per second will be given by:

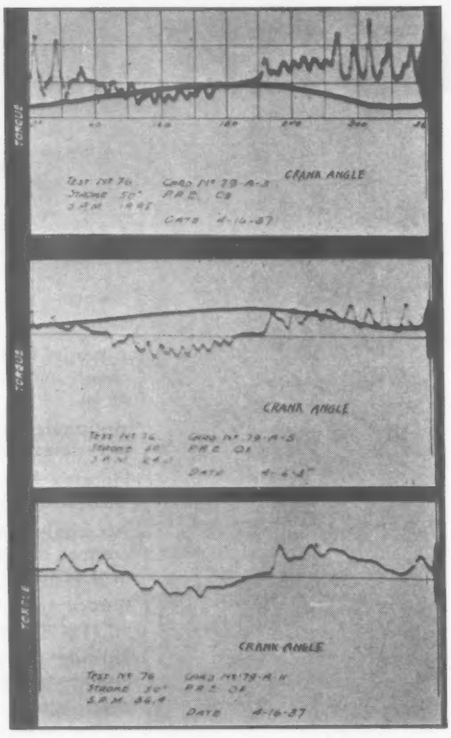

Fig. 18—Torque in gear unit. Two-cylinder engine, rotary weights with zero counterbalance effect. Well not connected

$$f = \frac{1}{2\pi} p$$

$$f = \sqrt{\frac{B}{A/2\pi}} \quad (93)$$

or $$f = \frac{\sqrt{A}}{2\pi} \quad (94)$$

6. Application of theory.

For an application of this theory calculations will be made for a single reduction system. Actual torque tests are available on this unit and later will be compared with theoretical results.

The following are approximate values for this unit:

I_s (crank shaft) $= \frac{\pi d^4}{32} = \frac{\pi (6.5)^4}{32} = 175.2$ in^4

I_s (pinion shaft) $= \frac{\pi (3.7)^4}{32} = 18.40$ in.^{4}

$k_1 = \frac{E_s I_s}{l} = \frac{12 \times 10^6 \times 175.2}{61} = 3.448 \times 10^7$ (See Equation 43)

$k_2 = K_2' N^2 = \frac{E_s I_s}{l} N^2 = \frac{12 \times 10^6 \times 18.4}{33.75} \times (9.4)^2 = 5.78 \times 10^6$ (See Equation 60)

$I_1 = 45{,}720$

$I_2 = 1{,}176$

$I_3 = N^2 i_4 = (9.4)^2 \times 342 = 30{,}220$ (See Equation 59)

$$A = \frac{k_2}{I_2}\left(\frac{I_2}{I_3} + 1\right) + \frac{k_1}{I_3}\left(\frac{I_3}{I_1} + 1\right) = \frac{1}{I_3} k_2 \left(\frac{I_2}{I_3} + 1\right) + k_1\left(\frac{I_3}{I_1} + 1\right) = 5.40 \times 10^5$$

$$B = \left(\frac{I_1 - I_2 + I_3}{I_1 I_2 I_3}\right) k_1 k_2 = 94.6 \times 10^7$$

Substituting in Equation 91 we have:

$$p_1 = \left[\frac{94.6 \times 10^7}{5.40 \times 10^5}\right]^{1/2} = 41.8$$

$$f_1 = \frac{41.8}{2\pi} = 6.65 \text{ per sec.} = 400 \text{ per min.}$$

$$p_2 = \sqrt{A} = 5.40 \times 10^5 = 735$$

$$f_2 = \frac{735}{2\pi} = 117/\text{sec.} = 7{,}020/\text{min.}$$

From the above it is seen that f_1 is about the frequency of the engine explosions and that f_2 is quite above the frequency of the engine ex-

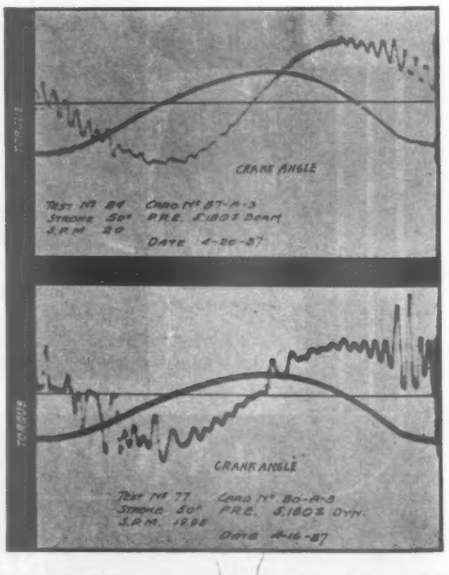

Fig. 19—Torque required to move beam and rotary counterbalance. Well not connected. Two-cylinder engine

plosions. It is also higher than the number of tooth contacts so that no trouble would normally be expected in this range. For double reduction units the frequency of tooth contacts will be much higher and may be a factor to consider.

The case considered above is for rotary counterbalance. If beam balances are considered, I_1 will be very small. A will then be increased slightly. As I_1 is small (assume 1/30 of value for

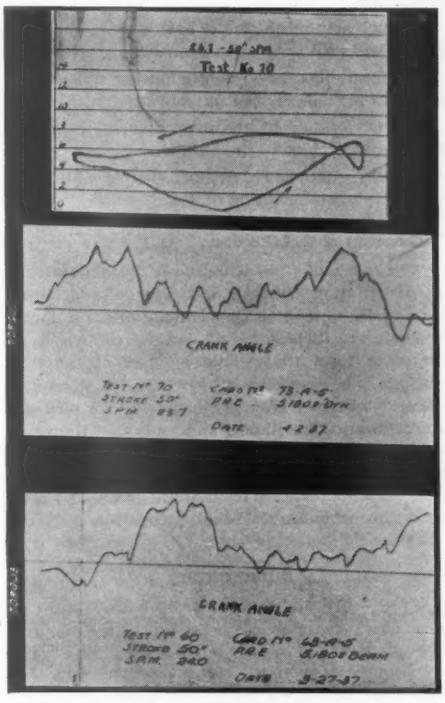

Fig. 20—Torque with beam and rotary counterbalance. Well connected. Single-cylinder engine

rotary balance). B will increase greatly as it is an indirect function of I_1. The values of A and B will be of the order of:

$$A = 5 \times 10^7$$

$$B = 2 \times 10^7$$

We would then have approximate value of p as being:

$$p = .6 \text{ or } f = .1/\text{sec. or about 6 per min.}$$

The lower frequency is, therefore, cut by a factor of 100. This is below the range where any harm from resonance would be expected and the upper frequency would be increased above the range where any difficulties would be expected.

7. Experimental data.

Figure 17 shows torque data obtained on a well equipped with a rotary counterbalance so loaded as to have inertia but no counterbalance effect. In this case the well was unhooked and the engine was used to drive this mass. The only unbalanced load which was involved is that of the pitman which caused a small deviation from the zero torque line. As can be seen from the data shown, it is noted that at 31.8 s.p.m. there is a definite variation in torque during each engine cycle which is very pronounced and of considerable magnitude. In this case there is actually a torsional vibration set up by each engine's explosions which results in a torsional vibration about the normal torque line. It will be noticed that at 24.3 s.p.m. this vibration is very small and at 35.8 s.p.m. this torsional vibration is much smaller than at 31.8 s.p.m. This indicates there is a critical speed somewhere about 31 s.p.m. and that the damping is sufficient at both the higher and lower speeds so that this amplitude is not as great as at the critical speed. All the above data was taken on a single cylinder driving a single reduction gear box.

Figure 18 shows data on the same setup except that a two-cylinder vertical engine was used in making the test. In this case it is seen that the critical speed occurred at somewhat less than 19 s.p.m. At 24 s.p.m. the vibration had been practically damped out. The reason for this lower critical speed is that the gear system has a fixed natural period of vibration and that by using a multicylinder engine this resonant condition is reached at a lower well speed by an equivalent number of engine explosions per minute.

Figure 19 shows a case of a well with a two-cylinder vertical engine but with equivalent amount of beam and rotary counterbalance. In this case it is seen that the vibration with the rotary counterbalance is considerably worse than with the beam counterbalance. It is difficult to say just what is the cause of the smaller amount

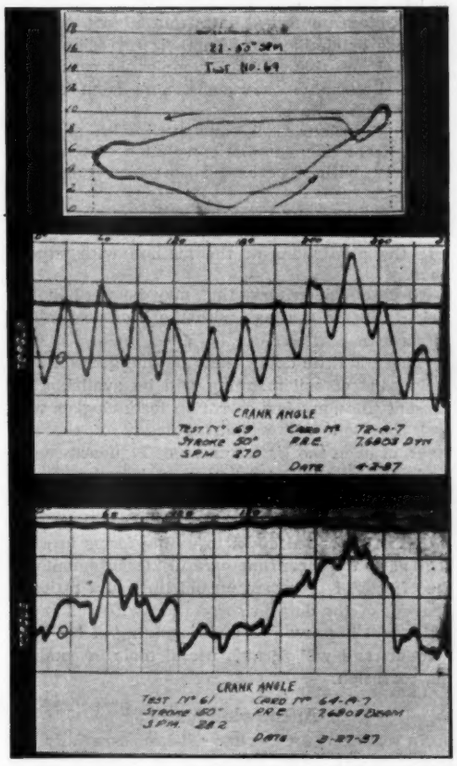

Fig. 21—Torque with beam and rotary counterbalance. Well connected. Single-cylinder engine

of vibration with the beam balance. However, it should be pointed out that there was a small amount of rotary balance present in this case as the master crank for the rotary balance was left on.

Figure 20 shows a case of beam and rotary counterbalance where the well was hooked on. The dynamometer card is shown. It can be seen from the torque cards that the well is practically balanced; i.e., the peak torque on the upstroke is practically equal to the peak torque on the downstroke. In this case very little difference can be seen between the two cards.

In Figure 21 torque cards are shown for beam and rotary balance when operating at 27 s.p.m. In this case it is seen that there is a very pronounced torsional vibration occurring about the peak torque line for the rotary balance. The engine in this case was a single-cylinder engine and some indications of the explosions can be seen for beam balance but they are in order of magnitude considerably less than that caused by the well load, whereas the vibration in the case of the well equipped with rotary balance is greater than the well load and, therefore, considerably more important.

Figure 22 shows a case where the well was equipped with rotary counterbalance and a two-cylinder vertical engine. In this case the vibrations at low speeds are very noticeable. The middle card shows the load versus crank angle and the lower card shows the regular dynamometer card. In this case it is seen that there is no unusual condition shown in the dynamometer cards even though there is a very definite torsional vibration present in the gear unit.

Figure 23 shows torque cards taken at a relatively fast cycle. This corresponds to a 42-54-inch cycle. With the rotary counterbalance the well is operating faster.

The tests which have been included have been picked with the viewpoint of showing that there are torsional vibrations present in the gear systems of pumping units. These vibrations in any particular unit and with any particular prime mover will be maximum at the critical speed and will reduce rapidly at both higher and lower speeds. The operation at one of these critical speeds will, no doubt, be detrimental to the unit. In the case of beam counterbalance the masses in the geared system are such that the critical or natural frequency of the system are normally above the operating speeds or prime mover used for pumping service. In the case of units using a rotary counterbalance with its high moments of inertia the critical or natural frequency occurs in the range of operating speeds of the prime movers used. The natural frequency can be varied by changing shaft sizes, shaft lengths, moment

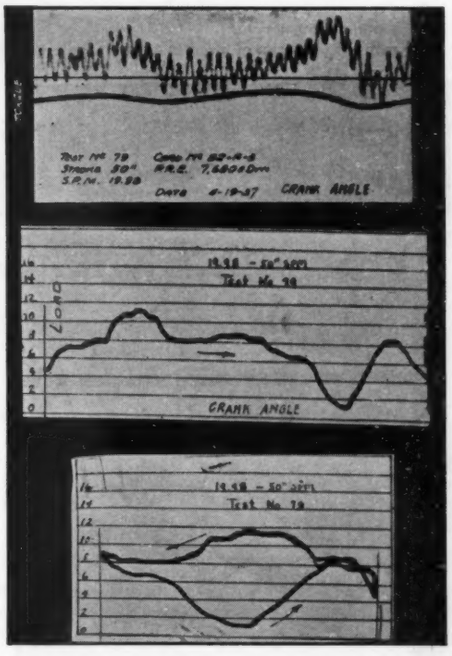

Fig. 22—Torque with well connected. Rotary counterbalance and two-cylinder engine

of inertia of the pulley, relation between effective amount of counterbalance and the moment of inertia of counterbalance and by changing the moment of inertia of the gear and the gear ratio. With all these factors available the designer, therefore, can in most cases so proportion the parts as to eliminate presence of torsional vibration and also to give sufficient strength, etc.

Conclusions

Besides the fact that gear units should be applied on the basis of peak torque, the data and theory presented in this paper show:

1. That the engine-drive service factors, as included in Table 3 and Figure 1 of A.P.I. Standards

No. 11-E, are not correct, and result in excessive penalties to properly equipped single-cylinder engines.

2. That torsional vibrations can be set up in gear drives as used on pumping units, and must be given some consideration in future designs.

3. That the use of maximum load in figuring peak torque will give units larger than necessary, if based on calculated loads at high speeds. At normal speeds the agreement is believed to be reasonable.

4. The Institute's subcommittee for rating of speed reducers should give further consideration to the above facts; and, as soon as sufficient data have been collected, revise the standards in accordance with the facts.

Appendix

Symbols

T = torque
t = time
r = radius of sprocket, gear or crank
R = pitman pull
L = length of stroke or twice crank radius
P = maximum polished-rod load
Pe = load at tail bearing
W = weight of counterbalance
We = effective counterbalance
Wr = weight of rods
Wo = weight of oil
F = force
N = speed, in r.p.m. or s.p.m.
n = ratio of engine speed to well speed
g = acceleration of gravity
Q = production, bbl. per day
C = constant
e = volumetric efficiency
S = net piston force
d = plunger diameter, in.
I = moment of inertia of mass, in.-lb. per squared sec.

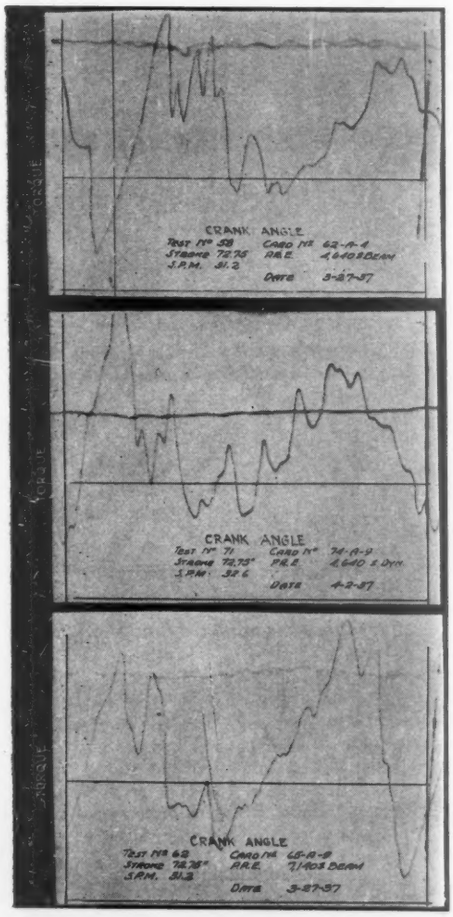

Fig. 23—Torque with beam and rotary counterbalance. Well connected. Single-cylinder engine

I_s = moment of inertia of shaft (in.⁴)
ϕ = angle of twist (radians)
k = torque necessary to produce an angle of twist of 1 radian (in.-lb. per radian)
E = modulus of elasticity in shear
V = weight on horsehead (Figure 7)
α = angular acceleration
f = natural frequency

Value of Soil-Survey

(Continued from Page 102)

1. Map the soils traversed according to type as determined by:
(*a*) Texture (coarse, fine, colloidal, etc.)
(*b*) Aeration (wet or dry, access to air, etc.).
(*c*) Water (pH, average moisture content, variability, etc.).
(*d*) Total acidity.
(e) Dissolved salts (especially Cl, SO_4, NO_3, CO_3).
(*f*) Resistivity.

These values of measured quantities can probably best be the averages of well-distributed tests in each soil type.

2. Obtain numerical data from other pipe lines in these or similar soils on their corrosion experience. From this, and soil samples, he can:

(*a*) Determine "soil constants" from experience of other lines.

(*b*) Correlate "soil constants" with soil test data. From this a usable correlation of some soil property with experienced corrosion might be found.

(*c*) Subject any proposed criterion of soil corrosiveness to the cut-and-try tests above to correlate the predictions of the method with experience.

3. Establish criteria that may be used in the field to locate coatings with the best probability of success.

There is little doubt that, as time goes on, better means of soil mapping will be available. At present there are few corrosion technologists who feel confident of recognizing many of the soil types of even the U. S. Bureau of Standards tests. Perhaps, by the interchange of information on corrosion experience and the critical examination of proposed criteria of corrosiveness, these criteria can be boiled down to usable forms in each region. In the meantime careful measurements of the effects of corrosion on old lines and rational analysis of the data in correlation with soil properties will improve our understanding of the phenomena, and will furnish useful tools in combating corrosion.

Acknowledgment

In closing, the writer wishes especially to thank Messrs. Scott Ewing, I. A. Denison, G. I. Rhodes, and H. E. Haring who have been kind enough to read the manuscript of this paper and to offer many valuable suggestions.

Appendix

A. Comments and suggestions from Scott Ewing.

In addition to several illuminating comments upon corrosion in the presence of oxygen in acid soils, and the effect of dissolved salts in alkaline soils, Scott Ewing gives us the relation between annual cost and corrosion determinants in acid soils. Referring to his paper[8] he writes that further examination of the cost records yield the correlation:

$$C = \frac{790\,(A - 5)}{R}$$

Where:

C = average annual cost of maintaining the pipe line, in dollars per hundred feet, over a period of 33 years.
A = milli-equivalents of soil acid per 100 grams.
R = ohm centimeters resistivity,

and A and R are averages over wide areas in each type of soil, as before.

B. Suggestions of I. A. Denison

I. A. Denison suggests the following method in recording pit depths: ". . . . to divide each pipe length into a certain number of equal areas, and to measure all of the pits above some minimum pit depth on each area. This need not be done for every joint of pipe in each soil type, but for some definite fraction of the total length, such as every fourth joint." The data obtained in this manner can be analyzed by any of the methods proposed by Scott, Ewing, Rhodes or Martin.

The principal requirements of useful measurements are:

1. Inclusion of *all* pits in each unit area deeper than some arbitrarily-set standard.

2. Measurements on contiguous groups of unit areas, to include several units of area.

3. Distribution of these groups as widely as possible in each soil type.

4. Other data such as age, size of unit area, and complete description of soil.

C. Comments of G. I. Rhodes.

The work of G. I. Rhodes on the statistics of pit distribution yields a precisely defined curve. Mr .Rhodes notes that the semi-log relation, found by Ewing to fit best his pit-depth area data, is of the same form that would be used if the best straight line were drawn to fit Rhodes' data. The precision obtained from the large number of measurements used by Rhodes indicates that the semi-log relation really is a curve, and the safest extrapolation is made on that basis. Mr. Rhodes invites communications from those interested seriously in promoting and studying this type of analysis.

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Continuous Residuum Coking by Delayed Coking Process

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Standard Oil Co. (Indiana), Whiting, Ind.*

Coking has for many years been an important process in the refining of petroleum. It is well known that, by a combination of crude-residuum coking and gas-oil cracking, a higher over-all gasoline yield is obtained from crude than by the combination of residuum viscosity breaking and gas-oil cracking. The widespread use of coking in present-day refining operations can probably be attributed to the higher gasoline yields obtainable by this process. The high cost of the earlier methods of conventional batch-still coking, however, has led to the development of continuous coking methods which offer appreciable advantages over the older method. The "delayed coking" process developed by the Standard Oil Co. (Indiana) has been in commercial operation for several years, and is superior to the batch-still method in many respects.

This process is based on the principle of rapidly heating the stock to be coked to a high temperature and charging the heated material into a vertical coking drum, where coking is effected by means of the contained heat. Thus, while the temperature of the residuum leaving the heating coil is sufficiently high to cause coking, the time of contact in the furnace is short, and actual formation of coke is delayed until the stock is introduced into the coking drum. This has suggested the name of "delayed coking."

COMMERCIAL APPLICATION OF DELAYED COKING

One of the first commercial applications of this process was a unit constructed by the Standard Oil Co. (Indiana) at its Whiting refinery in 1930 for processing Mid-Continent reduced crude. A more recent application was the incorporation of the delayed-coking principle in a combination crude-running and cracking unit put into operation by the same company early in 1938. Inasmuch as the process as applied in both plant installations is essentially the same, a complete description of only the earlier unit is included here.

The important features of this process are covered by patents issued in the United States and foreign countries.

EQUIPMENT

The coking unit described herein has a capacity of 2,860 bbls. (42 gallons) per day of Mid-Continent reduced crude of a gravity of 19.0 degrees A.P.I. A simplified flow sheet of this unit is shown in Figure 1. The Mid-Continent residuum at a temperature of 685° F. is withdrawn from a crude-reducing unit (not shown) and pumped to the furnace, where it is heated to coking temperature.

A. Furnace

The furnace employed in this unit is a typical radiant- and convective-section heater. The feed enters at the bottom of the convective section and passes upward countercurrent to the flow of the combustion gases. Parallel flow through two tubes is employed in the lower half of the convective section, and series flow in the upper half. The oil then enters the radiant section, in which only series flow is employed. The radiant section

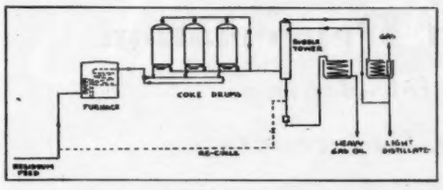

Fig. 1—Process flow diagram for continuous residuum coking

contains tubes on each side wall and on the front wall, and the hot oil passes in a U-shaped path through the lowest tubes on the three walls, then back over the reverse route in the second lowest tubes, and so on. After passage through the wall tubes, and oil flows through a single row of roof tubes, and out of the furnace. The temperature at the roof outlet is 910° F. in normal operation.

The furnace is equipped to burn both gas and oil. Forced- and induced-draft fans operate in connection with an air preheater to supply hot combustion air to the burners. Firing is controlled by the oil-exit temperatures.

B. Circulating Ring

After leaving the furnace the residuum enters a "circulating ring," and from this ring is withdrawn to the coking-drum bottom inlet. The hot residuum flows around the ring in two directions from the point of entrance, being proportioned by valves at this point. The flow through each side of the ring is regulated manually to maintain the desired temperature in each leg. The two streams meet at the point of exit, and the combined stream is discharged into the coking drum. This method of introducing the charge into the drums provides, as will be noted, a system of lines which has no dead ends. The undesirable deposition of coke at various points is thereby avoided, and the diversion of the hot-oil stream from one drum to another is facilitated.

C. Coking Drums

The heated residuum flows from the circulating ring into the bottom of the coking drum at a uniform rate, until the drum is filled with coke—the time required being determined by previous experience. Three coking drums are provided so that operation is continuous. The coking drums are of riveted construction, each 16 feet in diameter and 35 feet in height. The upper head is ellipsodal, and contains a manhole 2 feet in diameter. The lower head is conical with a slope of 45 degrees, and has at the bottom a manhead 6 feet in diameter. The lower manhead is hinged to a carrier on a monorail so that it can be pulled out of the way during the coke-removing operations. Suitable vapor, steam, and water lines are connected from each drum to the common respective headers for the three drums to provide adequate means for alternating the drums during the coking cycle.

The method of coke removal used in this particular installation is by cable pulling. The cables are supported in the drums at definite levels progressively increasing in distance apart as the top of the drum is approached. On each level are 10 hooks welded to the walls of the drum and spaced equally around the circumference, so that five wires may be placed across the diameter of the drum. These wires are used to support six 1,000-foot lengths of seven-eighths inch cable. The cable is coiled in flat spirals on the under side of the wires, and is held in place by means of bag ties, which consist of short lengths of wire with the ends twisted together.

D. Fractionating System

The hot vapors from the drum are introduced into a fractionating tower of the bubble-cap type The naphtha produced in the coking operation passes overhead from this tower and through a water-cooled coil to a gas separator. Cold naphtha is pumped back to the fractionating tower to provide reflux. Heavy gas oil, suitable for cracking-unit charging stock, its withdrawn from the bottom of the fractionating tower through a box cooler.

OPERATION OF THE UNIT

Operation of the unit as a whole is continuous. In normal operation each drum is filled with coke in 36 hours. During the latter part of the coking cycle on each drum, the hot overhead vapors are passed down-flow through the next drum to be used in order to preheat this drum in preparation for receiving the stock to be coked. When the desired amount of coke has accumulated in the first drum, the hot feed is switched to the second drum. The first drum is allowed to stand for 24 hours in order to increase the hardness and decrease the volatile matter content of the coke. The drum is then cooled by steaming for 15 minutes, followed by water cooling for one hour.

The drum is then ready for cleaning. The manheads are removed, and a cable leader is run from a winch and attached to the end of the cable in the coke. The cable is pulled at a rate of 40 feet to 60 feet per minute. The coke, falling on a chute, is quenched and discharged into a railroad car. A record is kept of the number of times each cable is pulled. Inasmuch as the coke is hardest and the pulling the most difficult in the bottom of the drum, each new cable is used in the lowest

***A. P. I.*— Paper presented at annual meeting, Chicago, 1938**

Author's title: "Continuous Coking of Residuum by the Delayed Coking Process."

position until it has been pulled 12 times. It is then moved to the next higher position for 12 pulls, and so on—until, after 72 pulls, the cable is discarded. The cables increase in diameter by formation of coke between the strands—until finally they become too bulky for satisfactory use. Rarely is a cable discarded because of mechanical failure. The total time to remove the manheads and pull the cable is about four hours.

After the cable has been pulled, the coke adhering to the walls of the drum is removed by hand. The cross-wires and cable are then placed in position working downward through the drum. After the cable has been mounted, the top and bottom manheads are replaced, the air in the drum is expelled with steam, and the drum is heated by vapors from the preceding drum in the manner described above. The time required for the total cycle is 108 hours. A summary of the distribution of time for the various operations is given in Table 1.

Typical operating data for the unit are summarized in Table 2.

In general, coking within the furnace roof tubes and sometimes in the upper wall tubes limits the length of runs. After 900 to 1,000 hours of continuous operation the pressure drop through the furnace has increased approximately 100 pounds per square inch, and there are visible indications of localized overheating of the roof tubes. The effects of "on-stream" time on the operating conditions of the furnace are shown in Table 3.

The feed rate is varied somewhat, depending on the character of the residuum and also the condition of the furnace; but, in general, is about 106 bbls. to 119 bbls. per hour.

TABLE 1—DISTRIBUTION OF TIME IN A TYPICAL COKE-DRUM CYCLE

Operation—	Time required (hours)
Coking	36
Setting	24
Steaming	¼
Water cooling	1
Removing heads; pulling cables, scraping, rewinding cables, and replacing heads	32¾
Steaming	2
Vapor heating	12
Total cycle	108

TABLE 2—OPERATING CONDITIONS FOR DELAYED-COKING UNIT

Flows, bbl. (42-gal.) per hour:	
Residuum charge	119
Bubble-tower condensate	80
Bubble-tower net overhead	24.3
Bubble-tower top reflux	27
Temperatures, deg. F.:	
Residuum to furnace	685
Residuum to coke drums	910
Coke-drum vapors	784
Bubble-tower bottom	576
Bubble-tower top	308
Furnace temperatures:	
Above convective section	1,270
Leaving convective section	834
Pressures, lb. sq. in., gauge:	
Charge to furnace	160
Coke drums	3.8

YIELD AND QUALITY OF PRODUCTS

The product yields obtained under normal conditions of operation are summarized in Table 4.

The yield of stabilized gasoline of 400° F. end-point is 22.4 per cent of the residuum charged to the coking unit. This gasoline has an A.S.T.M. octane number of 55.0, and a Reid vapor pressure of 8.0 pounds per square inch.

The coke produced differs somewhat throughout the drum. In the lower section the coke is dense, with hardly any visible porosity, and the volatile matter is low. At higher levels, the coke progressively becomes softer, more brittle, and the volatile matter increases. The hardness of coke produced by delayed coking is compared in Table 5 to that of coke produced in horizontal batch stills. This comparison is based on a quantitative method for determining the hardness—which consists of dropping a 25-pound weight from a height of 30 inches onto lumps of coke weighing 50 grams each, and noting the percentage of material thus produced, which is retained on a sieve of half-inch mesh. If all the coke is retained on the sieve, the hardness is 100. If all

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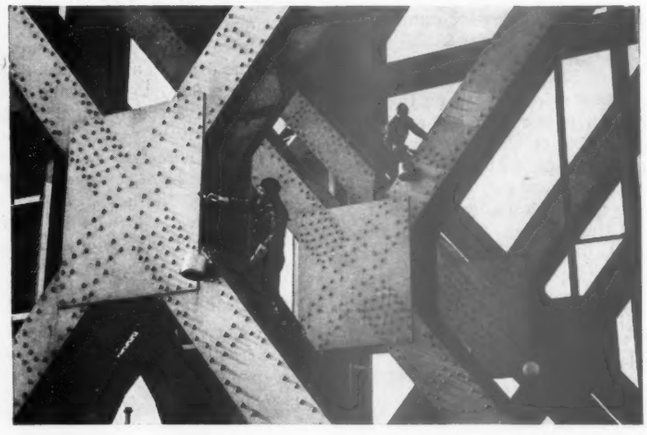

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SYNTHETIC RESINS

Despite severe handicaps some motor fuel marketers are promoting the use of agricultural alcohol as a motor fuel constituent

of it passes through the sieve, the hardness is 0.

The average volatile-matter content of the coke is approximately 10.5 per cent by A.S.T.M. Method D-271-33. Usually the volatile matter of coke from the top of a drum will be about 2 to 3 per cent higher than that of coke from the bottom of the drum.

TABLE 3—EFFECT OF TIME ON STREAM ON FURNACE OPERATION

	Temperatures (deg. F.)					Pressures (lb. per sq. in., gauge)			
Hours operating	Flow (barrels per hour)	Into furnace	Into wall tubes	Into roof tubes	Furnace outlet	Into furnace	Into wall tubes	Into roof tubes	Furnace outlet
15	108	650	774	872	909	160	150	127	14
900	106	635	824	900	912	240	220	170	17

FACTORS AFFECTING COKE CHARACTERISTICS

The production of substantial quantities of lump coke (material retained on a 3-inch grizzly) is desired, because usually a higher price can be obtained for lump coke than for screenings. Therefore, an important objective in the operation of the delayed-coking unit is the adjustment of conditions to produce the maximum coke hardness consistent with reasonable ease of removal from the drum. It is possible to produce coke of such hardness that frequent cable breakages occur; and, as a result, the drums cannot be kept on schedule, and the unit must be shut down. The principal conditions which appear to control coke hardness are: 1, furnace-outlet temperature; 2, time coke is allowed to remain at elevated temperatures; 3, efficiency of drum insulation; and, 4, characteristics of the residuum.

TABLE 4—YIELDS FROM COKING A.P.I. MID-CONTINENT RESIDUUM (GRAVITY, 19.0 DEGREES A.P.I.)

	Yield (per cent of residuum) (per cent by weight)	Gravity (deg. A.P.I.)
Gas	7.2	1.398 (spec. grav.)
Light distillate	20.4	53.6
Heavy distillate	67.2	24.4
Coke (dry)	12.4	
	107.2	

Yields Corrected to 400 Degrees F. Endpoint, Stabilized Gasoline

Gas	4.5
Gasoline	22.4
Gas oil	69.1
Coke	12.4
	108.4

Several experimental runs have been made in which a furnace-outlet temperature of 925° F. was employed (normal temperature is 910° F.). This type of operation increased the percentage of lump coke by about 12 per cent. Approximately the same increase may be obtained by allowing the coke to stand in the drum at the coking temperatures for a period of 12 to 20 hours before cooling. In cases where drum equipment is available, the latter method will result in fuel economies, in as much as lower furnace temperatures will be required for the same production of lump coke. From the preceding discussion it is apparent that the efficiency of insulation will be a factor affecting coke hardness, in as much as it affects drum temperature. The addition of cracked residuum to the charging stock also tends to increase the hardness of the coke. It has been observed in several experimental runs that the introduction of 10 to 15 per cent cracked residuum into the charging stock will increase markedly the coke hardness, and the percentage of lump coke will be increased by about 10 to 15 per cent at constant temperature and coking time.

TABLE 5—COMPARISON OF COKE HARDNESS

	Hardness
Delayed coking:	
Bottom of drum	85
Middle of drum	71
Top of drum	59
Horizontal batch-still coking:	
Bottom	94
Middle	89
Top	55

COMBINATION COKING UNITS

The ultimate gasoline yield, including that from cracking the coke-still gas oil, can be improved by recirculating the heavy ends of the coke-still gas oil within the coking system. This principle was employed in the construction of a large combination crude-distillation, gas-oil-cracking, and coking unit which recently started operation. The coking system of this unit is similar to that described above, except that it is integrated with the cracking and distillation system and charges, in addition to reduced crude, heavy recycle stock boiling above about 850° F. from both the coking and cracking systems. It has been possible to achieve a close balance between the coking system and the crude-distillation and gas-oil-cracking systems.

To Expand Brandon Refinery

CALGARY, Alberta, Nov. 14.—It is announced that the Central Refineries plant at Brandon, Manitoba, controlled by Anglo-Canadian Oil Co. and which operated to a capacity of about 800 bbls. daily in August and September, will be extended in 1939, and a cracking unit installed. Plans for other refineries in the West, and possibly at the head of the lakes, are also under consideration.

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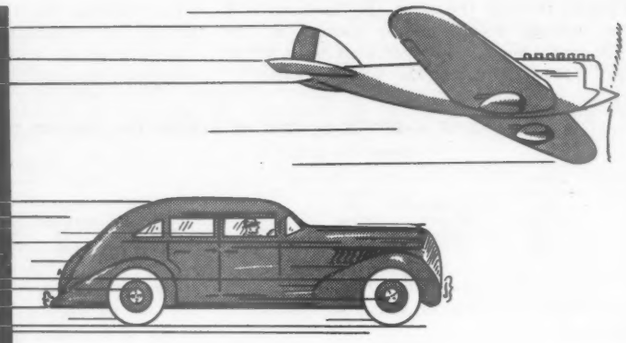

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Revivification Characteristics of Bauxite Used in Filtration

By R. H. HUBBELL, JR., and R. P. FERGUSON

Attapulgus Clay Co., Philadelphia, Pa.*

Continued interest in bauxite as a filtering medium as indicated by its adoption by numerous refineries for the percolation of lubricating-oil stocks, has been due largely to the fact that it possesses the property, under certain conditions, of indefinite revivification without substantial degradation in adsorptive power. The precise extent of this degradation, however, is of paramount importance to the refiner who desires to arrive at a sound economic comparison between bauxite and other commercial adsorbents; and it is, therefore, felt that a detailed analysis of revivification characteristics is justified.

In a previous discussion[1] the authors have presented an analysis of the fundamental characteristics of bauxite, including a discussion of the influence of variables not encountered in commercial operation with such adsorbents as fuller's earth. The conclusions reached in this study briefly may be summarized by stating that, in the percolation of residual stocks, optimum results are obtained by operation at the maximum practicable temperatures of burning and filtration, whereas best results in the decolorization of light-colored distillate stocks require operation at the minimum practicable burning and filtering temperatures. New bauxite was also shown to exhibit a "solvent" effect upon finished-oil quality somewhat greater than that of other adsorbents, a characteristic which was shown to be substantially lost after continued re-burning, and to be of little practical significance—in as much as it was accompanied by a rather pronounced drop in viscosity. No data were presented, however, to show the influence of re-burning upon the decolorizing efficiency.

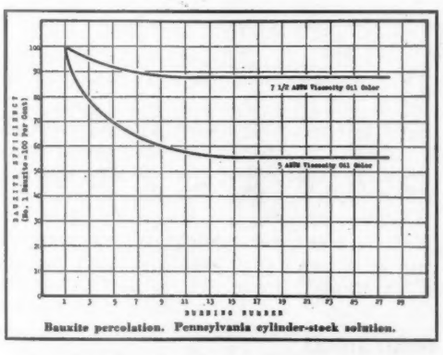

7 1/2 ASTM Viscosity Oil Color
5 ASTM Viscosity Oil Color
BURNING NUMBER
Bauxite percolation. Pennsylvania cylinder-stock solution.

Fig. 1—Bauxite efficiency vs. burning number

It is the objective of the present discussion, therefore, to analyze the effect of continued revivification upon both the decolorizing value and the "solvent" action of bauxite—basing the conclusions upon actual plant revivification, in as much as laboratory re-burning is, in this respect, notoriously inconclusive. In view of the fact that the efficiency loss suffered by bauxite on continued re-use, as well as its average efficiency in comparison with fuller's earth, is profoundly influenced by the type and source of stock to be treated, it has been felt desirable to include data covering the filtration of a number of oils. Included, therefore, are the solution percolation of Pennsylvania and Mid-Continent residual stocks; the straight filtering of dewaxed Pennsylvania and solvent-extracted Mid-Continent bright stocks; the percolation of Pennsylvania neutral and acid-treated Colombian distillates; and the filtration of a Pennsylvania petrolatum stock. For each of these services it is proposed to illustrate: (1) The degree of degradation suffered by bauxite through a number of plant revivifications; (2) the average decolorizing efficiencies to be anticipated as compared with new bauxite and with No. 1 fuller's earth of the improved, or extruded, type now available; and, (3) the influence of revivification upon the "solvent" action of bauxite as shown by finished-oil tests.

***A.P.I.*— Paper presented at annual meeting, Chicago, 1938**

Both laboratory and plant data are included, the results presented in tabular form representing the laboratory evaluation of plant-burned samples, which were re-dried prior to testing; while the curves are intended to represent the average results to be anticipated in plant operation on the various stocks. The conclusions are derived largely from operation in a plant in which bauxite is utilized through nine re-burnings for distillate filtration, during which period it is maintained at low burning temperatures, and following which it is revivified at 1,250 to 1,300° F. for subsequent use in residual-stock filtration. Laboratory procedures used have been discussed previously.[2]

Throughout this discussion all bauxite values are expressed in terms of No. 1 bauxite and of freshly-burned fuller's earth—no attempt being made to cover herein the average efficiency of fuller's earth on re-burning, in as much as refinery practice varies in this respect, and optimum values previously have been presented.[3,4] In the following sections, where data are presented on solution filtration, the filtrate oil color is expressed in terms of the "viscosity oil color" rather than color of the oil-naphtha filtrate.

SOLUTION PERCOLATION OF RESIDUAL STOCKS

1. Pennsylvania Cylinder Stocks

The curves in Figure 1 demonstrate the effect of burning number from 1 to 28 upon the percolation efficiency of bauxite used in the filtration of Pennsylvania cylinder stock in 60 per cent naphtha dilution to finished viscosity oil colors of 5 and 7½ A.S.T.M.—all burnings having been effected at temperatures of 1,200 to 1,300° F. It will be observed that when finishing to 7½ A.S.T.M. color the yields manifest a gradual drop through the first few revivifications, following which the values level off at some 87 per cent of that of new, or No. 1, bauxite. In as much as new bauxite exhibits an efficiency slightly higher than that of No. 1 fuller's earth on a volume basis, it will be seen that the average value of bauxite in terms of new fuller's earth becomes 90 per cent. In as much as this efficiency is maintained throughout the life of the bauxite (60 to 70 cycles if handling losses average in the vicinity of 1.5 per cent per burning) the economic advantage for bauxite over fuller's earth in this type of service readily is apparent.

It should be pointed out, however, that the foregoing are based upon a finished viscosity oil color of 7½ A.S.T.M. The efficiency of bauxite at lighter colors drops off rather rapidly, and settles at a lower value, as shown by the efficiencies given at 5 A.S.T.M. viscosity oil color in Table 1—although, in this connection, it must be noted that the initial value, as compared with fuller's earth, is quite high at 5 color (138 per cent by volume) a fact which offsets the greater drop in efficiency.

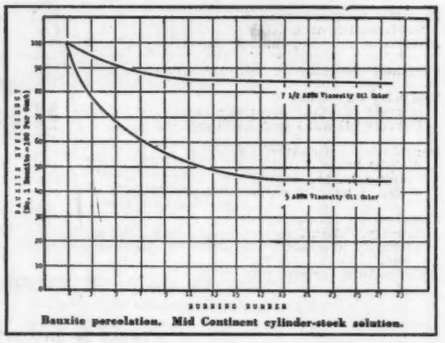

7 1/2 ASTM Viscosity Oil Color
5 ASTM Viscosity Oil Color
BURNING NUMBER
Bauxite percolation. Mid Continent cylinder-stock solution.

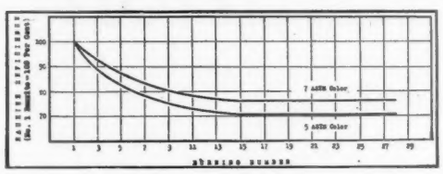
Fig. 2—Bauxite efficiency vs. burning number

In as much as in normal operation fresh bauxite will be added as make-up following the burning of a given charge, the filter yields obtained for a given stock will be quite uniform. This constitutes one of the chief advantages of bauxite operation, viz., the possibility of the prediction of filter yields with, consequently, more satisfactory and uniform filter-house operation.

As stated previously, the "solvent" action of bauxite is relatively pronounced in the early stages of its adsorbent life, but gradually diminishes until the point is reached at which this action, as shown by finished-oil inspections, is no greater than that of other commercial adsorbents.

*Author's title is "Revivification Characteristics of Bauxite Used in Percolation Filtration."

For example, reference to Table 1 shows that, in filtering Pennsylvania cylinder stock through freshly-burned bauxite, a 7½ color oil is produced which shows a gravity of 27.6 degrees A.P.I., a Conradson carbon content of 0.75 per cent, and a viscosity of 132 sec. at 210° F. (undewaxed). On the other hand, filtration of the same stock through No. 25 bauxite resulted in a gravity of



Bauxite percolation. Pennsylvania bright stock

Fig. 3—Bauxite efficiency vs. burning number

27.1, a carbon of 1.35, and a viscosity of 136—these latter values being in close accord with the tests of the oil treated with fuller's earth. It is felt, therefore, in the light of these and other similar data, that the markedly lower carbon and higher A.P.I. gravity attendant upon bauxite filtration are obtainable only from fresh material, and then are accompanied by some sacrifice in viscosity.

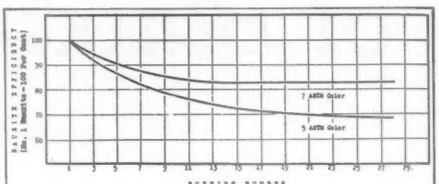
Perhaps the most significant practical aspect of the foregoing lies in the effect of bauxites upon finished-oil "cast" or "bloom," a factor which is related definitely to the "solvent" action of the beauxitic adsorbents. Experience in this connection has shown that, as bauxite passes through several revivifications, the finished-oil cast improves—until, ultimately, a point is reached at which the bloom is comparable to that imparted by new fuller's earth. The precise burning number at which this condition is reached is a variable depending upon individual stocks and conditions, but it may be accelerated by underwashing or by otherwise increasing the burning temperature at which revivification is carried out.

2. Acid-treated Mid-Continent Residual Stock

While considering the subject of solution filtration, it is felt significant to discuss the percolation (60 per cent naphtha) of an acid-treated steam-sweetened Mid-Continent residual stock, which is illustrated in Figure 2. It will be noted that the relation between efficiency (No. 1 bauxite = 100 per cent) and burning number is essentially similar to that which prevailed in the case of the Pennsylvania stock, the average efficiency to which the curve settles being of the same order of magnitude. The value of the new material in terms of extruded fuller's earth, however, is of the order of 92 per cent on a volume basis. This figure is some 10 per cent lower than the corresponding value for the Pennsylvania stock, although the economic advantage over average fuller's-earth operation is still clearly evident.

The influence of burning number on the finished oils produced from the Mid-Continent stock is also shown in Table 1, and serves to confirm the conclusions drawn relative to the Pennsylvania oil, viz.: that, as revivification progresses, the finished-oil cast and inspection data tend to approach those characteristics of fuller's-earth filtration.

Before concluding the consideration of solution percolation, it is felt advisable to point out an



Bauxite percolation. Mid Continent bright stock (solvent-extracted).

Fig. 4—Bauxite efficiency vs. burning number

additional factor bearing upon the average results obtainable with bauxite, i.e., the gradual accumulation in the system of magnetic iron oxides and other materials such as fire clay, tramp iron, etc. There is present in all bauxites iron oxide in varying amounts which, owing to its dispersion throughout the bauxite grains, and to the fact that the greater part exists as Fe_2O_3, is difficult to remove economically. However, after passage through several refinery cycles, during which the material is burned in the presence of carbon, the iron content assumes the form of discreet particles of magnetic material which, coupled with con-

TABLE 1—BAUXITE PERCOLATION OF PENNSYLVANIA AND MID-CONTINENT CYLINDER-STOCK SOLUTIONS

Adsorbent—	Bauxite (30- to 60-mesh)								Extruded fuller's earth (30- to 60-mesh)		Bauxite (30- to 60-mesh)								Extruded fuller's earth (30- to 60-mesh)	
Percolation tests:																				
Stock used	Pennsylvania "A" cylinder stock										Mid-Continent cylinder stock									
Gravity, °A.P.I.	26.1										23.8									
Viscosity (Saybolt Universal) at 210° F., sec.	155										147.5									
Conradson carbon, per cent	2.1										2.2									
Solution naphtha, per cent	60										60									
Filtering temperature, °F.	180										180									
Burning temperature, °F.	1,200		1,200-1,300		1,200-1,300		1,200-1,300		900		1,200		1,200-1,300		1,200-1,300		1,200-1,300		900	
Adsorbent burning No.	1		5		15		25		1		1		6		13		20		1	
Adsorbent density, lb. per cu. ft.	56.9		58.8		59.5		59.8		31.6		56.9		58.9		59.3		59.9		31.6	
Finished viscosity oil color, A.S.T.M.	5	7½	5	7½	5	7½	5	7½	5	7½	5	7½	5	7½	5	7½	5	7½	5	7½
Viscosity oil yields:																				
Barrels (42-gal.) per ton	4.5	6.8	3.0	6.2	2.6	5.9	2.3	5.8	5.9	12.0	6.3	8.7	3.9	8.0	3.2	7.4	2.8	7.2	8.7	17.1
Barrels (42-gal.) per 1,000 cu. ft.	128	194	88.2	183	77.4	176	68.9	174	93	190	177	248	115	235	95	219	84	216	137	270
Percolation efficiency, per cent:																				
Weight basis	100	100	67	91	58	87	51	85	131	177	100	100	62	92	51	85	44	83	138	197
Volume basis (No. 1 bauxite equals 100 per cent).	100	100	69	94	60	91	54	90	72	98	100	100	65	95	54	88	48	87	77	119
Finished oil (undewaxed):																				
Gravity, °A.P.I.	...	27.6	...	27.3	...	27.2	...	27.1	...	27.2	...	25.0	...	24.9	...	24.6	...	24.5	...	24.4
Viscosity (Saybolt Universal) at 210° F., sec.	...	132	...	133	...	134	...	136	...	136	...	119	...	124	...	125	...	129	...	129
Conradson carbon, per cent	...	0.75	...	1.10	...	1.21	...	1.35	...	1.40	...	1.2	...	1.33	...	1.45	...	1.55	...	1.5

TABLE 2—BAUXITE PERCOLATION OF PENNSYLVANIA AND MID-CONTINENT BRIGHT STOCKS

Adsorbent—	Bauxite (30- to 60-mesh)								Extruded fuller's earth (30- to 60-mesh)		Bauxite (30- to 60-mesh)								Extruded fuller's earth (30- to 60-mesh)	
Percolation tests:																				
Stock used	Dewaxed Pennsylvania bright stock										Dewaxed solvent-extracted Mid-Continent bright stock									
Gravity, °A.P.I.	25.6										25.5									
Viscosity (Saybolt Universal) at 210° F., sec.	153										164									
Conradson carbon, per cent	1.54										0.79									
Filtering temperature, °F.	220										210									
Burning temperature, °F.	1,200		1,200		1, 200		1,250-1,350		900		1,200		1,200		1,200		1,250-1,350		900	
Adsorbent burning No.	1		4		8		25		1		1		5		9		20		1	
Adsorbent density, lb. per cu. ft.	56.9		58.0		59.0		59.8		31.6		56.9		58.8		59.2		59.9		31.6	
Finished viscosity oil color, A.S.T.M.	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7
Viscosity oil yields:																				
Barrels (42-gal.) per ton	5.2	76	4.5	68	4.3	62	3.7	59	9.5	153	61.1	11.2	5.5	10.2	4.8	9.9	4.3	9.2	11.6	23.1
Barrels (42-gal.) per 1,000 cu. ft.	148	2,160	131	1,975	127	1,830	111	1,765	150	2,240	174	319	162	300	142	293	129	275	183	365
Percolation efficiency, per cent:																				
Weight basis	100	100	87	90	83	82	71	78	183	201	100	100	90	91	79	88	71	82	190	206
Volume basis (No. 1 bauxite equals 100 per cent).	100	100	88	91	86	85	75	82	101	114	100	100	93	94	82	92	74	86	105	114
Finished oil:																				
Gravity, °A.P.I.	...	26.3	...	26.2	...	26.2	...	26.1	...	26.2	...	26.0	...	26.0	...	25.9	...	25.8	...	25.8
Viscosity (Saybolt Universal) at 210° F., sec.	...	142	...	143	...	147	...	148	...	147	...	144	...	145	...	145	...	146	...	146
Conradson carbon, per cent	...	1.3	...	1.44	...	1.49	...	1.44	...	1.45	...	0.5	...	...	...	0.65	...	0.55	...	0.6

tamination from the burning and handling equipment, constitutes a considerable body of inert matter.

Experience has shown that the difference in specific gravity between the bauxite and the iron-oxide particles is sufficient to provide a sharp separation by the use of conventional gravity-separating means—which also serve to remove impurities of lighter weight because of their larger size. The periodic purging of the filter-house charge by some such method is, therefore, felt to be warranted.

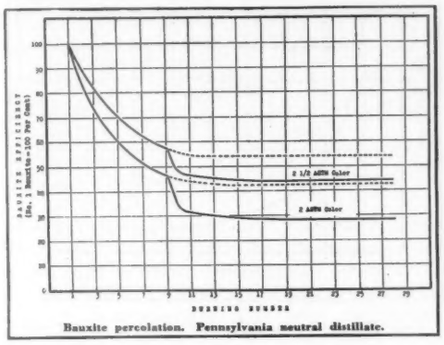


Fig. 5—Bauxite efficiency vs. burning number

STRAIGHT PERCOLATION OF BRIGHT STOCKS

1. Pennsylvania Bright Stock

Figure 3 illustrates the filter finishing of a Pennsylvania bright stock which, prior to dewaxing, had been solution-filtered through fuller's earth. The efficiency in terms of new material again is plotted against the burning number, and it is to be noted that bauxite utilized in this service suffers a slightly greater degree of efficiency loss than that characteristic of solution filtration. For example, the yields at 7 A.S.T.M. color indicate an ultimate bauxite efficiency of approximately 78 per cent of new material—which is equivalent to a volume-basis of 70 to 75 per cent of No. 1 extruded fuller's earth.

Previously-stated conclusions relative to finished-oil quality likewise apply to straight filtering as demonstrated by the data in Table 2. It should be pointed out, however, that in as much as cast is usually of paramount importance in this type of filtration, it is advisable to operate at the maximum practicable temperatures of burning and filtration, under which conditions the "solvent" action of the bauxitic adsorbents is lessened. Furthermore, attention is directed to the fact that oils filtered through bauxite at elevated temperatures (250 to 300° F.) do not manifest the "cracked" odor characteristic of fuller's-earth operation under similar conditions—thus enabling the refiner to take advantage of the high yields and improved-cast characteristic of high-temperature filtration.

2. Mid-Continent Bright Stock

The average results attendant upon the filtration through bauxite of a solvent-extracted Mid-Continent bright stock are summarized in Figure 4. In this case the average bauxite efficiency is found to be similar to that prevailing in the case of the more paraffinic stock, owing to the solvent extraction and the fact that the Mid-Continent stock was somewhat darker in color. The yield at which the bauxite curve levels is shown to be approximately 82 per cent of that of the No. 1 material, and the average efficiency compared to No. 1 improved fuller's earth is in the vicinity of 75 to 80 per cent if based on equal volumes—indicating that bauxite can be used to advantage on stocks of this type.

The tests of the finished oils produced are summarized in Table 2, the figures bearing out the aforementioned conclusion that percolated-oil quality approaches that obtained with fuller's earth as the bauxite matures, and that "quality pick-up" is obtainable from bauxite only at some sacrifice in viscosity.

DISTILLATE-STOCK PERCOLATION

1. Pennsylvania Neutral Distillate

Satisfactory filtration of light-distillate stock is one of the chief problems associated with the use of bauxite as a commercial adsorbent—depending, as it does, upon the maintenance of low burning temperatures. In as much as there is a practical lower limit to the temperatures at which occluded oil and color bodies can be burned out of the material, it is virtually impossible to escape some degradation in efficiency. Experience has shown, however, that provided revivification be effected at the lowest temperature requisite to the removal of carbon, this loss in initial decolorizing power may be kept at a minimum.

In this connection, the curves given in Figure 5 for the decolorization of Pennsylvania 180 neutral distillate are felt to be significant. These data are based upon operations in a refinery in which bauxite used for neutral percolation is maintained at the minimum practicable temperature (850 to 950° F.) through nine cycles, and thereafter burned at 1,250 to 1,350° F. and utilized for residual-stock filtration. The solid line from Nos. 1 to 9 and the dotted line from Nos. 10 to 30 represent the efficiencies which may be anticipated as a result of maintaining low temperatures of revivification. Under these conditions it will be observed that the curve levels off at a yield which is 55 per cent of the value of No. 1 bauxite—equivalent,

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on a volume basis, approximately to 55 to 60 per cent of new extruded fuller's earth.

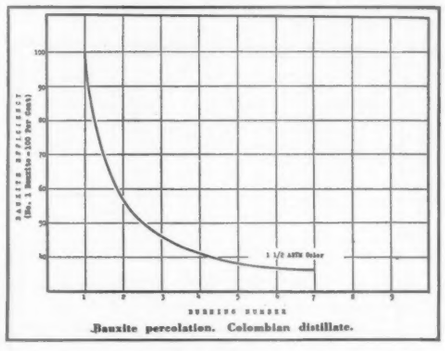
On the other hand, the solid curve from Nos. 10 to 20 represent actual efficiencies obtained from the later-numbered bauxites which had been subjected to the higher burning temperatures. It will be noted that, under these circumstances, the bauxite efficiency drops off to a value which is only 45 per cent of the new material. The corresponding curves at the lighter color show even lower values.

This difficulty in maintaining maximum yields of distillate stocks points toward the desirability of segregating different batches of material for this service—a procedure which can be readily effected, in as much as the average refiner segregates many different types of fuller's earth in various stages. The maintenance of optimum yields, however, obviously demands more precise control of the burning operation than that required in residual-stock service—although economic studies based upon the efficiencies shown in Figure 5 reveal that, at the maximum level indicated by the dotted curve, the employment of bauxite for the treatment of stocks of this type is justified provided segregation of low-burned material is accomplished. In many cases, for example, it is possible to utilize low-numbered bauxites for distillates, thereafter placing the material in residual-stock service.

From the standpoint of finished-oil quality, the chief point of significance rests in the improved odor of neutrals filtered through low-numbered bauxites. This characteristic likewise disappears subsequent to the first few revivifications. A number of oxidization tests have also shown a slight advantage for bauxite-filtered oils as compared with fuller's-earth percolation.

2. Percolation of Colombian Distillate

The curve in Figure 6 represents the filtration of an acid-treated Colombian distillate stock, and demonstrates the rapid degree of efficiency loss suffered by bauxite in this service. The initial yield is definitely lower as compared with fuller's earth than that characteristic of the Pennsylvania neutral, and the average yield obtained from late-numbered bauxites is very low—even under optimum conditions of re-burning. It will be observed that at No. 7 the curve reaches a value of only 37 per cent of No. 1—equivalent, on a volume basis, to only 35 to 40 per cent of new extruded fuller's earth. (In view of this low value, the tests were not extended beyond No. 7.) The conclusion appears inescapable, therefore, that bauxite cannot be utilized to advantage on this type of stock, unless operations can be balanced in such a fashion as to permit the use of Nos. 1 and 2 only—thereafter utilizing the material in residual-stock filtration.



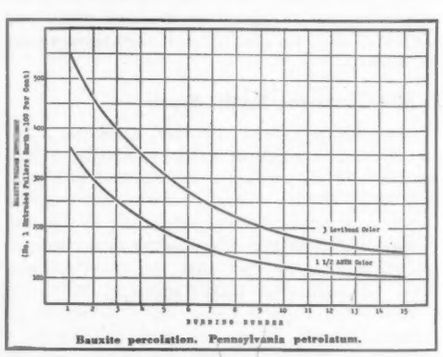
Bauxite percolation. Colombian distillate.

Fig. 6—Bauxite efficiency vs. burning number

It should be pointed out that stocks of this type occasionally, after acid treatment and caustic neutralization, contain inorganic substances which are precipitated upon the filtering medium during the filtration process. These compounds exert a "poisoning" effect on the filtering material—experience with bauxite having shown that degradation occurs roughly in proportion to the amount of these compounds removed from the charge stock during percolation.

Conclusions relative to filtered-oil quality conform, in the case of this stock, to those derived from the decolorization of Pennsylvania 180 neutral (Table 3).

In view of the foregoing discussion, it is felt conclusive that, owing to the sensitivity of bauxite in the filtration of light distillates, the results to be anticipated in plant practice are much less predictable than those characteristic of residual-stock percolation. The results reported on the two stocks discussed probably approximate the extremes as regards bauxite effectiveness, in as much as experience has shown in this respect



Bauxite percolation. Pennsylvania petrolatum.

Fig. 7—Bauxite volume efficiency (based on extruded fuller's earth) vs. burning number

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TABLE 3—BAUXITE PERCOLATION OF PENNSYLVANIA AND COLOMBIAN DISTILLATE STOCKS

Adsorbent—	Bauxite (30- to 60-mesh)								Extruded fuller's earth (30- to 60-mesh)		Bauxite (30- to 60-mesh)				Extruded fuller's earth (30- to 60-mesh)
Percolation tests:															
Stock used	Pennsylvania neutral distillate										Colombian distillate				
Gravity, °A.P.I.	29.9										23.5				
Viscosity (Saybolt Universal) at 100° F., sec.	185										109				
Color, A.S.T.M.	...										2½				
Filtering temperature, °F.	115										115				
Burning temperature, °F.	850		850-900		850-900		1,250-1,350		900		950	850-900	850-900	850-900	900
Adsorbent burning No.	1		5		9		20		1		1	2	3	7	1
Adsorbent density, lb. per cu. ft.	56.9		58.8		59.2		59.9		31.6		56.9	57.2	58.0	58.7	31.6
Finished viscosity oil color, A.S.T.M.	2	2½	2	2½	2	2½	2	2½	2	2½	1½	1½	1½	1½	1½
Viscosity oil yield:															
Barrels (42-gal.) per ton	25.3	39.3	15.5	27.5	11.6	22.4	7.3	17.3	47.1	73.5	9.2	5.3	4.3	3.4	18.7
Barrels (42-gal.) per 1,000 cu. ft.	720	1,115	456	809	343	663	219	518	745	1,160	262	152	125	102	295
Percolation efficiency, per cent:															
Weight basis	100	100	61	70	46	57	29	44	186	187	100	58	47	37	203
Volume basis (No. 1 bauxite equals 100 per cent).	100	100	63	73	48	60	31	47	103	104	100	58	48	39	113
Finished oil:															
Gravity, °A.P.I.	...	30.6	...	30.6	...	30.6	...	30.5	...	30.5	...	...	...	...	...
Viscosity (Saybolt Universal) at 100° F., sec.	...	178	...	180	...	179	...	180	...	180	...	...	...	...	...

that solvent-treated distillates respond in a manner essentially similar to the Pennsylvania neutrals. The necessity for the maintenance of low temperatures of re-burning for all stocks of this type is likewise felt to have been clearly established.

PETROLATUM FILTRATION

The percolation of petrolatum is, unquestionably, the service in which bauxite shows to the greatest advantage, in as much as the efficiency of bauxite as compared to fuller's earth frequently approaches 500 to 600 per cent by volume for new low-burned material. This fact is demonstrated by Figure 7, which presents a curve of volume-basis efficiency (compared to extruded fuller's earth) vs. burning number for a Pennsylvania petrolatum stock.

Here again is noted the necessity for the maintenance of low-burning temperatures, optimum conditions of re-burning having resulted in a final yield which is still in excess of extruded fuller's earth on a volume basis. This, it is felt, demonstrates the unquestionable advantage held by bauxite in the percolation of petrolatum stocks and waxes, a superiority which becomes even more marked when cognizance is taken of the fact that the filtrations upon which Figure 7 are based yielded petrolatums which were sufficiently free of taste and odor so that further purification was unnecessary.

SUMMARY

In summary, it may be stated that: (1) The average adsorption efficiency of bauxite, both as compared with new material and with fuller's earth, varies with the source and type of stock to be filtered and the method of filtration; (2) that, while fresh bauxite exerts a pronounced "solvent" action, this effect diminishes with continued revivification; and (3) that improved gravity and carbon are obtainable with only the low-numbered bauxites, and only then at the sacrifice of viscosity.

Economic comparisons show bauxite to possess an unquestionable advantage over fuller's earth in the decolorization of petrolatum stocks, residuals, and of distillate stocks—provided a balance is maintained whereby bauxite, in its early stages, is segregated for distillate filtration. The use of bauxite for paraffinic distillates exclusively has been shown to be a border-line case. The selection of adsorbent for a given service, therefore, remains an individual problem, and it is hoped that the data which have been presented herein will constitute a basis for the solution of such questions.

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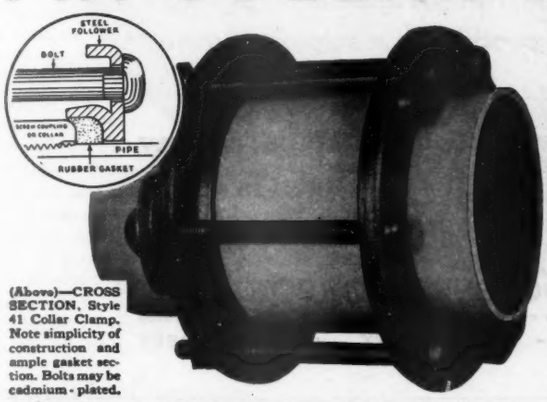

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CLAY TREATING

Hydrocarbons in the Lubricant Fraction of Petroleum

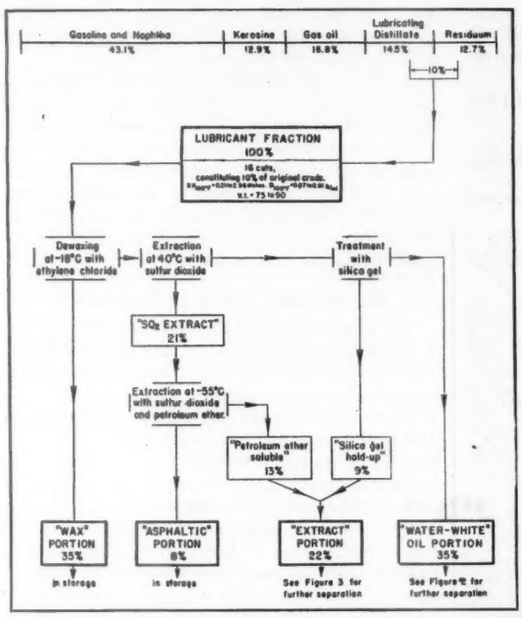


Fig. 1—Chart showing the separation of the lubricant fraction into four broad portions

By FREDERICK D. ROSSINI

National Bureau of Standards, Washington, D. C.; Director of A.P.I. Research Project 6

By the fall of 1933 the American Petroleum Institute Research Project 6 had made considerable progress on the resolution of the gasoline fraction of petroleum, and the advisory committee for the project decided that the time was then opportune to undertake also the investigation of the lubricant fraction. Accordingly, one of the units of the project began work on the lubricant fraction of the same lot of Mid-Continent petroleum which was serving as the source material for the project's study of the gasoline fraction.

At the time relatively little was known about the general constitution of the dewaxed lubricant fraction of petroleum, and practically nothing of the actual kinds of molecules in it. It was generally assumed, however, on the basis of a long extrapolation of the data obtained on the gasoline fraction, that the lubricant fraction of petroleum contained, in addition to the normal paraffins which had been shown to be the constituents of the higher-melting waxes, the following types of hydrocarbons:

1. Branched-chain paraffins (isoparaffins).

2. Molecules composed of naphthene (cycloparaffin) rings with paraffin side chains.

3. Molecules composed of aromatic rings with paraffin side chains.

4. Molecules composed of both naphthene and aromatic rings with paraffin side chains.

No one, however, had yet definitely established the presence of these kinds of molecules in the lubricating-oil fraction; nor demonstrated whether a given dewaxed lubricant fraction contained, in significant amount, all of these kinds of molecules, or just one or two or three kinds. This was one of the questions to be answered by the study undertaken by the project. Another was: How do these various kinds of molecules react to the different processes of fractionation, and in which final fractions will they be found?

This broad survey of the chemical constitution of the lubricant fraction of petroleum, which was carried on as part of the work of the Institute's Research Project 6 by Beveridge J. Mair, assisted at various periods by S. T. Schicktanz, F. W. Rose, Jr., C. B. Willingham, and A. J. Streiff, has now been completed. From this study, covering the period from 1933 to 1938, six research papers[1-6] and two general reports to the Institute[7,8] have resulted—setting forth in detail the procedures employed in the fractionation and separation of the material, the determination of the properties of the fractions obtained, and the correlation of these properties with those of pure hydrocarbons in order to identify the final "homogeneous" fractions. The magnitude of the investigation may be judged from the fact that it involved, in addition to the careful and extensive processing of the material, the making of the following approximate number of determinations of properties: 95 of molecular weight; 185 of carbon and hydrogen content; 75 of boiling point of 1 mm. mercury; 730 of density; 1,500 of refractive

A.P.I. **— Paper presented at annual meeting, Chicago, 1938**

TABLE 1—REPORT OF THE EXAMINATION OF A SAMPLE OF CRUDE PETROLEUM TAKEN FROM THE BRETT NO. 6 WELL IN 1928. EXAMINATION MADE BY THE PETROLEUM EXPERIMENT STATION OF THE U. S. BUREAU OF MINES AT BARTLESVILLE, OKLA.

Brett Well No. 6
3,865-3,872 ft.
Continental Oil Co.

Sample 38,161
Ponca City field
Wilcox sand

Oklahoma,
Kay County
Section 8-25n-2e Indian

By E. L. Garton and Fred G. Edwards, July 16, 1938

General Characteristics

Specific gravity, 0.814 — Gravity, °A.P.I., 42.3
Sulfur, per cent, 0.11
Viscosity, Saybolt Universal, at 77° F., 35 seconds — Color, greenish black
Viscosity, Saybolt Universal, at 100° F., 35 seconds

Distillation, Bureau of Mines Hempel Method

Dry distillation — Barometer, 746 mm. — First drop: 32° C. (90° F.)

Temperature (°C.)	Cut (per cent)	Sum (per cent)	Specific gravity of cut	A.P.I. gravity of cut (deg.)	Viscosity at 100° F. (sec.)	Cloud test (°F.)	Temperature (°F.)
Up to 50	2.0	2.0	0.644	88.2	...	...	Up to 122
50— 75	3.2	5.2	0.664	81.6	...	...	122—167
75—100	7.2	12.4	0.708	68.4	...	...	167—212
100—125	9.0	21.4	0.736	60.8	...	...	212—257
125—150	7.4	28.8	0.756	55.7	...	...	257—302
150—175	7.3	36.1	0.774	51.3	...	...	302—347
175—200	6.3	42.4	0.791	47.4	...	...	347—392
200—225	6.2	48.6	0.806	44.1	...	...	392—437
225—250	6.5	55.1	0.819	41.3	...	...	437—482
250—275	7.6	62.7	0.834	38.2	...	...	482—527
Vacuum distillation at 40 mm.							
Up to 200	3.9	3.9	0.851	34.8	40	15	Up to 392
200—225	5.3	9.2	0.858	33.4	45	35	392—437
225—250	5.1	14.3	0.870	31.1	56	50	437—482
250—275	4.5	18.8	0.881	29.1	81	70	482—527
275—300	4.5	23.3	0.891	27.3	140	90	527—572

Carbon residue of residuum, 5.3 per cent; carbon residue of crude, 0.7 per cent.

Approximate Summary

	Per cent	Specific gravity	A.P.I. gravity (deg.)	Viscosity at 100° F. (sec.)
Light gasoline	12.4	0.686	74.8	
Total, gasoline and naphtha	42.4	0.740	59.7	
Kerosene distillate	12.7	0.813	42.6	
Gas oil	16.6	0.846	35.8	
Nonviscous lubricating distillate	9.0	0.864—0.884	32.3—28.6	50—100
Medium lubricating distillate	5.3	0.884—0.896	28.6—26.4	100—200
Viscous lubricating distillate	...	...	...	Above 200
Residuum	12.5	0.941	18.9	
Distillation loss	1.5	...	...	

index; 220 of refractive dispersion; 6,400 of kinematic viscosity; 130 of aniline point; 15 of aromatic content of hydrogenation; and 95 of optical rotation.

It is the purpose of the present report to summarize the results obtained in this study of the chemical constitution of the lubricant fraction of petroleum, and to present some conclusions deduced from it.*

Description of the Petroleum Investigated

The petroleum which served as the source material for the lubricant fraction studied in this investigation was obtained in 1928 from the Brett No. 6 well in the Ponca City field in Oklahoma, through the courtesy of the Marland Oil Co. (now part of the Continental Oil Co.)† The exact location of this well is in the C of the NE SE of Section 8-25n-2e, Kay County, Oklahoma. This well, located near the crest of the Ponca anticlinal structure, produced oil from the uppermost part of the Wilcox sand formation of the Simpson group, Middle Ordovician in age. The top of the producing horizon was encountered at a depth of 3,865 feet, the total depth of the hole being 3,872 feet. The Brett No. 6 well, brought in as a producer under its own gas pressure on July 14, 1919, was placed on the pump on January 21, 1926, and produced under vacuum until October 26, 1936—when the well was plugged and abandoned because of salt-water encroachment.‡

Of the original crude petroleum obtained from the Brett No. 6 well in 1928, a portion has been preserved under nitrogen in a steel drum at the Marcus Hook plant of the Sun Oil Co. In 1938 a sample was taken from this lot, and an analysis,§ reported in Table 1, was made of it at the Petroleum Experiment Station of the U. S. Bureau of Mines at Bartlesville, Okla.

In connection with the results shown in Table 1, and their relation to the present report, two points should be noted:

1. The analysis is representative of the crude petroleum as it came from the well in 1928, and as it was first subjected to processing for the work of A.P.I. Research Project 6.

2. This crude petroleum is particularly low in the heavier end of the lubricating-oil distillate, as represented by material distilling below 300° C. at a pressure of 40 mm. mercury, and having a viscosity greater than 200 seconds, Saybolt, at 100° F.

A fairly complete report on the hydrocarbons, and their estimated amounts, in the gasoline fraction of this same lot of petroleum was given in the report to the Institute a year ago.‖

Method and Extent of Separation

The method of resolving this lubricant fraction of petroleum consisted in the judicious use of distillation, crystallization, extraction, and adsorpton.

Separation into broad portions.

Figure 1 illustrates the scheme of separating the lubricant fraction into four broad portions having quite different properties.[1,2,3,4] The upper part represents the U. S. Bureau of Mines analysis of the original crude petroleum, and shows what portion was taken to constitute the lubricant fraction under investigation. This material, composed of 16 distilled fractions, was then dewaxed at —18° C. with ethylene chloride* to produce a "wax" portion containing, in addition to the true wax, a considerable portion of clear oil. The remaining material was then subjected to extraction at about 40° C. with liquid sulfur dioxide to produce a "sulfur-dioxide extract." The material insoluble in the sulfur dioxide was treated by adsorption with silica gel to produce a "water-white" oil and a portion representing the "silica-gel hold-up." The "sulfur-dioxide extract" was brought into solution in liquid sulfur dioxide at —55° C., and extracted with petroleum ether at the same temperature to produce a "petroleum-ether-soluble" portion and an "asphaltic" portion—the latter from the material remaining in the sulfur-dioxide layer. The "petroleum-ether-soluble" material was combined with the "silica-gel hold-up" to make what may be called the "extract" portion of the lubricant fraction.† In this manner the original lubricant fraction was separated into the following four broad fractions:

1. The "wax" portion, 35 per cent.
2. The "asphaltic" portion, 8 per cent.
3. The "extract" portion, 22 per cent.
4. The "water-white" oil portion, 35 per cent.

Before the systematic distillation and extraction, the properties of the "water-white" oil portions were roughly as follows: Boiling range, at 1 mm. mercury, 190° to 270° C.; kinematic viscosity at 100° F., 0.2 to 1.1 stokes (100 to 500 seconds, Saybolt); viscosity index, 90 to 110; density at 25° C., 0.86 to 0.89 grams per milliliter (31° to 26° A.P.I.); refractive index at 25° C. (N_D), 1.47 to 1.49; specific dispersion, $\left(\frac{N_F - N_B}{d}\right)$, 0.0102.

Similarly, for the "extract" portion, the properties were as follows: Boiling range, at 1 mm. mercury, 170° to 290° C.; kinematic viscosity at

*The author is indebted to B. J. Mair and C. B. Willingham for aid in assembling the charts and tables prepared for this report.

†See also Page 469 of Reference 9.

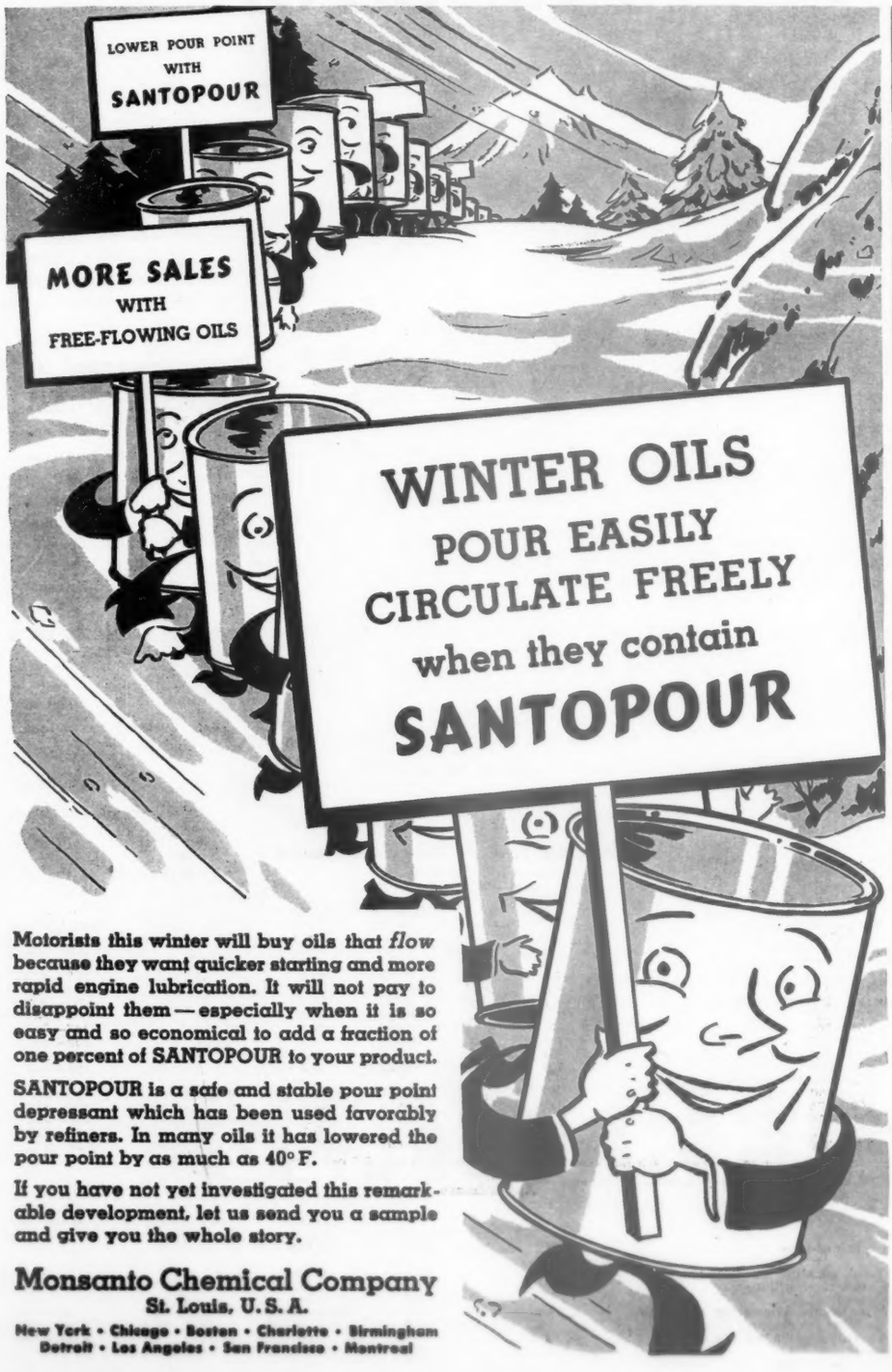
‡The author is indebted to Walter Miller of the Continental Oil Co. for this complete description of the now "historic" Brett No. 6 well.

§The author is indebted to Harold M. Smith, of the U. S. Bureau of Mines at Bartlesville, Okla., for this report of analysis.

‖Report entitled "A Decade of Research on the Chemical Constitution of Petroleum." See Reference 10.

*See Pages 558-60 of Reference 1.

†A change in nomenclature is made here. In previous reports the "sulfur-dioxide-extract" material was labeled "extract." For convenience in discussion, the general name "extract" is here reserved for the sum of the above "petroleum-ether-soluble" material and the "silica-gel hold-up."



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100° F., 2 to 20 stokes (1,000 to 9,000 seconds, Saybolt); viscosity index, —80 to —150; density at 25° C., 0.98 grams per milliliter (12° A.P.I.); refractive index (N_D), 1.56; specific dispersion, $(\frac{N_F - N_C}{d})$, 0.0195.

The so-called "wax" portion (which contains a considerable amount of clear oil in addition to the true wax) and the "asphaltic" portion (the greater part of which is solid at room temperature, and contains all the black tar-like constituents) were placed in storage, and have not been investigated. The "extract" portion and the "water-white" oil portion were each subjected to an exhaustive separation, with respect both to size and type of molecules. These separations are shown graphically in Figures 2 and 3.

Separation of the "Water-White" Oil Portion

Figure 2 illustrates the manner in which the "water-white" oil portion was fractionated exhaustively by distillation and extraction.[3] This oil was first subjected to a systematic distillation in high vacuum, through about eight stages, to produce a large number of substantially constant-boiling fractions. An indication of the properties of these fractions, which are mixtures of different

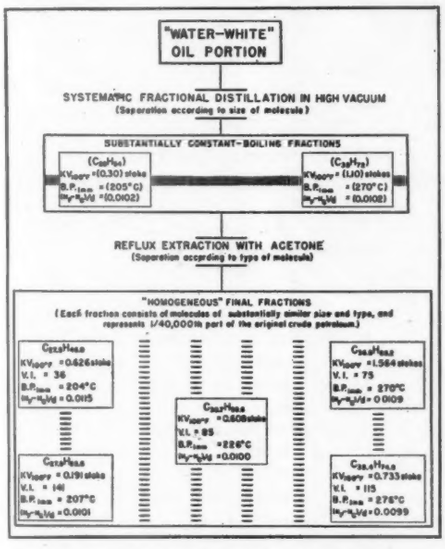
"WATER-WHITE" OIL PORTION
SYSTEMATIC FRACTIONAL DISTILLATION IN HIGH VACUUM
(Separation according to size of molecule)
SUBSTANTIALLY CONSTANT-BOILING FRACTIONS
REFLUX EXTRACTION WITH ACETONE
(Separation according to type of molecule)
"HOMOGENEOUS" FINAL FRACTIONS
(Each fraction consists of molecules of substantially similar size and type, and represents 1/40,000th part of the original crude petroleum.)

Fig. 2—Chart showing the exhaustive separation of the "water-white" oil portion

kinds of molecules, is given in the two blocks, one at the low-boiling and one at the high-boiling end. These substantially constant-boiling fractions were then subjected to extraction with reflux in 46-foot columns, using acetone (plus some water for the more soluble fractions) as the solvent, to produce the final fractions shown in the lower part of the figure. The nature of these final fractions is indicated by the properties given in the blocks for the most soluble and the least soluble fractions of both the low-boiling and high-boiling ends, together with one fraction in the center of the "spread" formation.

Separation of "Extract" Portion

Figure 3 illustrates the exhaustive separation of the "extract" portion, by distillation and extraction.[4] This material was processed in the same manner as was the "water-white" oil, except that the extraction occurred in 55-foot columns using methyl cyanide (plus some acetone for the less soluble fractions) as the solvent. The nature of the final fractions is indicated by the properties in the blocks.

Final "homogeneous" fractions.

Each of the final "homogeneous" fractions of both the "water-white" oil and "extract" portions was of the order of 15 grams (representing 1/40,000th part of the original crude petroleum from which it came), and consisted of compounds of substantially similar size and type. These fractions, while far from being pure compounds, appear to be nearer to pure compounds than any material (excepting normal paraffin hydrocarbons) hitherto separated from the lubricant fraction of any crude petroleum.

Content of sulfur, nitrogen, and oxygen.

While this investigation was concerned primarily with the hydrocarbon constituents of the lubricant fraction, sufficient data were obtained to show the distribution of the sulfur, nitrogen, and oxygen in the final "homogeneous" fractions of the "water-white" oil and "extract" portions and in some of the intermediate fractions.

Concerning the four portions into which the lubricant fraction was first separated (see Figure 1) the following statements may be made:

1. Although no analyses were actually made of the "wax" portion, its manner of separation indicates that it is substantially pure hydrocarbon material, and contains no sulfur or nitrogen in significant amount.

2. Analyses of the fractions of the "water-white" oil portion (see Figure 2) showed that it was substantially pure hydrocarbon material, and contained no sulfur, nitrogen, or oxygen in significant amount.

3. Although no analyses were actually made of the "asphaltic" portion, the method of separation would tend to concentrate in it a relatively large part of all the sulfur, nitrogen, and oxygen in the original lubricant fraction.

4. Analyses of the "extract" portion (see Figure 3) showed that the fractions of the distillate contained, on the average, about 0.9 per cent of sulfur, 0.1 per cent of nitrogen, and about 0.5 per cent of oxygen. These percentages correspond to about 0.1, 0.03, and 0.1 atom of sulfur, nitrogen, and

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oxygen, respectively, in a molecule containing a total of about 65 atoms of carbon plus hydrogen. The final process of extraction distributed this non-hydrocarbon material among the various final "homogeneous" fractions, as shown in the blocks in the lower part of Figure 3 and as illustrated by the curves in Figure 4. The latter figure gives, as a function of the percentage extracted, the percentage by weight of sulfur, nitrogen, and oxygen in these final fractions of the "extract" portion. It appears that the nitrogen concentrates rather completely in the most soluble fractions; the sulfur concentrates in the more soluble fractions (but not as sharply as the nitrogen) with a maximum in the neighborhood of about 25 per cent extracted; and the oxygen is greatest in the most soluble fractions, and decreases slowly toward zero at the least soluble end. In terms of atoms per molecule, the *maximum* amount of sulfur in any one fraction was found to be 0.17 atom in a molecule containing 30 carbon atoms and 40 hydrogen atoms, or about 1 atom in 400; of nitrogen, 0.19 atom in a molecule containing 27 carbon atoms and 30 hydrogen atoms, or about 1 atom in 300; and of oxygen, 0.33 atom in a molecule containing 27 carbon atoms and 30 hydrogen atoms, or about 1 atom in 170.

Properties Determined and Method of Correlation

Because of the limited amount of starting material available for this investigation, the above-reported separation of the "water-white" oil and "extract" portions of the lubricant fraction was forced to come to a halt at the attainment of "homogeneous" fractions—leaving the drive toward pure compounds from the dewaxed lubricant fraction of petroleum to be made with a larger quantity of starting material in another investigation.* However, with "homogeneous" fractions (containing only molecules of substantially similar size and type) available from both the "water-white" oil and "extract" portions of the lubricant fraction, a comparison of the properties of these "homogeneous" fractions with those of pure hydrocarbons of high molecular weight† has made it possible to deduce with considerable confidence the kinds of molecules constituting the various fractions.

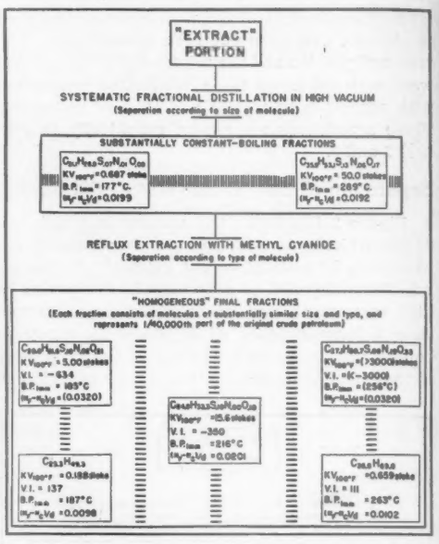
"EXTRACT" PORTION
SYSTEMATIC FRACTIONAL DISTILLATION IN HIGH VACUUM
(Separation according to size of molecule)
SUBSTANTIALLY CONSTANT-BOILING FRACTIONS
REFLUX EXTRACTION WITH METHYL CYANIDE
(Separation according to type of molecule)
"HOMOGENEOUS" FINAL FRACTIONS
(Each fraction consists of molecules of substantially similar size and type, and represents 1/40,000th part of the original crude petroleum)

Fig. 3—Chart showing the exhaustive separations of the "extract" portion

Properties.

As many different properties as practicable were determined in order to leave no reasonable doubt as to the conclusions drawn from the comparison of the properties of the "homogeneous" fractions with those of pure hydrocarbons. The following properties were determined on all the important final fractions:[2,4] (1) Molecular weight; (2) content of carbon and of hydrogen; (3) content of sulfur, nitrogen, and oxygen; (4) boiling point at a pressure of 1 mm. mercury; (5) density, d; (6) refractive index, N_D; (7) refractive dispersion, $N_F - N_C$; (8) kinematic viscosity at 100° and 210° F.; (9) aniline point; and (10) optical rotation, $[\alpha]_D^{20}$.

From the above properties the following functions of various properties‡ were calculated for the "homogeneous" fractions: (11) Molecular formula, $C_nH_{2n+x}S_wN_yO_z$, from (1), (2), and (3); (12) specific refraction $\left(\frac{N_D^2+1}{N_D^2-2}\cdot\frac{1}{d}\right)$ from (5) and (6); (13) specific dispersion $\left(\frac{N_F-N_C}{d}\right)$ from (6) and (7); and (14) kinematic viscosity index (V.I.) from (8).

Determination of aromatic content.

In addition to the determination of the above properties, it was necessary to ascertain, for a given fraction, how much of the hydrogen deficiency, as expressed by negative values of x in the formula C_nH_{2n+x}, was due to naphthene (cyclo-

*This second investigation on a larger quantity of starting material (about 15 times that of the first investigation) was undertaken two years ago as one of the problems of A.P.I. Research Project 6. A preliminary report on the progress of this second investigation is now being published (see R. T. Leslie[11]).

†A considerable impetus and an increased degree of certainty were given to this work of deduction of molecular structure by the publication in 1936 of the data obtained by Mikeska[12] on the synthesis and properties of hydrocarbons of high molecular weight in the laboratories of the Standard Oil Development Co.

‡See the discussion in References 8 and 10 regarding the usefulness and importance of such functions of various properties.

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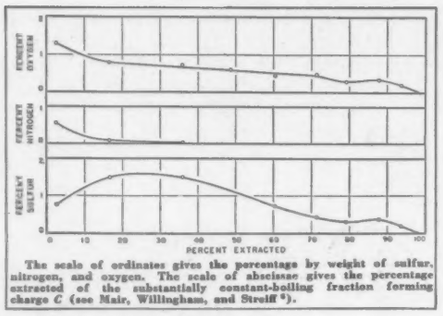
paraffin) rings and how much to aromatic rings. This was determined by subjecting certain selected fractions to hydrogenation under conditions which produced substantially complete saturation of the molecules without any breaking down of the structure.§ The properties of these fractions were measured after hydrogenation, including determination of the molecular weight and content of carbon and hydrogen. From the molecular formula before and after hydrogenation, the number of carbon atoms in aromatic rings in the fraction before hydrogenation was determined.

Method of correlation and deduction of molecular structure.

Figures 5, 6, and 7 show some of the correlation charts. Figure 5 gives a plot of the specific refraction against the number of carbon atoms per molecule;[3 6 14] Figure 6, the specific dispersion;[3 6 15] and Figure 7, the aniline point.[6]

§See Reference 5 for details and Reference 6 for discussion concerning the absence of olefinic compounds.



The scale of ordinates gives the percentage by weight of sulfur, nitrogen, and oxygen. The scale of abscissae gives the percentage extracted of the substantially constant-boiling fraction forming charge *C* (see Mair, Willingham, and Streiff [6]).

Fig. 4—Chart showing the content of sulfur, nitrogen, and oxygen in one series of the final "homogeneous" fractions of the "extract" portions

A simple illustration may be given of the actual procedure followed in deducing the general identity of the molecules in one of the final "homogeneous" fractions—selecting, for simplicity, one containing no nonhydrocarbon material:*

1. The following values of the properties of the selected fraction are first determined:†

Carbon content	89.75	per cent by weight
Hydrogen content	10.246	per cent by weight
Molecular weight	334.5	grams per mole
Density, at 25° C.	1.004	grams per milliliter
Refractice index, at 25° C.	1.573	(N_D)
Refractive dispersion, at 25° C.	0.0202	(N_F—N_C)
Boiling point	217	°C.
Kinematic viscosity, at 100° F	16.0	stokes
Kinematic viscosity, at 210° F.	0.201	stoke
Aniline point	6	°C.

From the carbon and hydrogen content and the molecular weight is obtained the molecular formula, C_nH_{2n+x}, with x being equal to —16:

Molecular formula, $C_{25}H_{34}$

From the refractive index and density is calculated the specific refraction:

$$\text{Specific refraction,} \quad 0.3282 \left(\frac{N^2-1}{N^2+2}\right)\frac{1}{d}$$

From the refractive dispersion and density is calculated the specific dispersion:

$$\text{Specific dispersion.} \quad 0.0201 \left(\frac{N_F-N_C}{d}\right)$$

From the viscosity at the two temperatures is calculated the kinematic viscosity index:

Viscosity index, —365

2. The specific dispersion, 0.0201, is considerably higher than that which would be expected for aromatic-free material 0.0098 to 0.0100 (see Figure 6), and indicates definitely presence of aromatic groups in this fraction. The specific refraction, 0.3282, would be that for an aromatic-free fraction having $x = -0.3$ but not $x = -16$ (see Figure 5); and this also points toward the presence of aromatic groups. (Aromatic groups increase, while naphthene rings decrease, the specific refraction.) The value of the aniline point, 6° C., is indicative of a high content of aromatic groups (see Figure 7).

3. The fraction is subjected to hydrogenation at 225° C. at a pressure of 200 atmospheres until the specific dispersion drops to 0.0100, which indicates substantially aromatic-free material (see Figure 6).

4. The following values of properties of the hydrogenated materials are determined;

Carbon content	87.13	per cent by weight
Hydrogen content	12.872	per cent by weight
Molecular weight	344.6	grams per mole
Density, at 25° C.	0.933	grams per milliliter
Refractive index, at 25° C.	1.502	(N_D)
Refractive dispersion, at 25° C.	0.0093	(N_F—N_C)
Boiling point	193	°C.
Kinematic viscosity, at 100° F.	3.50	stokes
Kinematic viscosity, at 210° F.	0.118	stoke
Aniline point	87	°C.

As before, there are calculated the following:

Molecular formula, $C_{25}H_{44}$

$$\text{Specific refraction,} \quad 0.3163 \left(\frac{N^2-1}{N^2+2}\right)\frac{1}{d}$$

$$\text{Specific dispersion,} \quad 0.0100 \left(\frac{N_F-N_C}{d}\right)$$

Viscosity index, —150

5. The specific dispersion, 0.0100, shows that the hydrogenated material is aromatic-free (see

*From other information and data on this petroleum (see References 6 and 10) it is known that this selected fraction contains no olefinic hydrocarbons in significant amount, and that the molecules are composed of naphthene rings, aromatic rings, and paraffin groups.

†The properties given are not those of an actual "homogeneous" fraction; but, for convenience in dission, have been interpolated to whole numbers for the carbon and hydrogen atoms per molecule. The properties represent very closely those which such a fraction would actually have.

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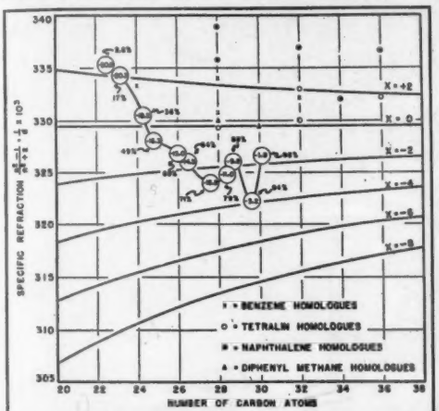
Figure 6). The molecular formula, $C_{25}H_{44}$, gives, in C_nH_{2n+x}, an x value of —6, which means that the molecule contains 4 naphthene rings after hydrogenation. The value of the specific refraction, 0.3163, is in very good agreement with the value 0.3161 (see Figure 5) calculated for a 4-ring naphthene ($x = -6$). The value of the aniline point of the hydrogenated material, 87° C., correlates very well with that for a 4-ring naphthene (see Figure 7).

6. The increase in the number of hydrogen atoms per molecule on hydrogenation is 10; and indicates that, in the original molecule, there are two aromatic groups, joined through two carbon atoms as in the naphthalene nucleus. This is further substantiated by the value of the specific



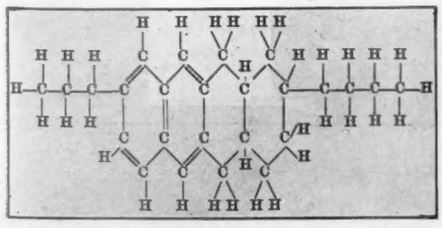
The values of x are those of the formula C_nH_{2n+x}. The line $x = +2$ gives values for pure paraffin hydrocarbons; $x = 0$, one-ring naphthenes (cycloparaffins); $x = -2$, two-ring naphthenes; $x = -4$, three-ring naphthenes; $x = -6$, four-ring naphthenes; $x = -8$, five-ring naphthenes. The points marked with crosses, open circles, solid circles, and triangles give the values for the respective aromatic hydrocarbons indicated. The series of large circles (the numbers inside representing values of x and the numbers outside representing per cent extracted) give the values for one series of homogeneous fractions of the "extract" portion (see Mair, Willingham, and Streiff [9]).

Fig. 5—Chart showing the value of the specific refraction of various molecules plotted against the number of carbon atoms per molecule

dispersion of the original fraction, 0.0201, which is to be compared with values of about 0.0185 to 0.0200 for molecules containing a naphthalene nucleus and values of about 0.0150 to 0.0160 for molecules containing two separate benzene rings (see Figure 6).

7. The values of the boiling point, density, and refractive index for each respectively in accord with the above conclusions. (The values of refractive index and density combined have already been tested in the specific refraction.)

8. The "homogeneous" fraction from petroleum, therefore, consists substantially of molecules composed of two naphthelene rings, plus two aromatic rings condensed as in a naphthalene nucleus, plus paraffin side chains containing 7 carbon atoms (assuming the naphthene rings to be cyclohexyl rather than cyclopentyl).* The question as to just how the naphthene rings are joined to the aromatic nucleus, and where the paraffin side chain or chains are attached to the ring, cannot be answered from the present data. The following is one of the possible ways in which the given component parts may be assembled to form the complete molecule:



*See Reference 6. Inasmuch as the two aromatic rings are condensed, it appears likely that all the rings are condensed (i.e., joined together through two carbon atoms).

9. The data shows definitely that the aromatic and the naphthene rings are in the same molecule. This may be proved in the following way: On hydrogenation, the molecular formula of the given "homogeneous" fraction changes from $C_{25}H_{34}$ to $C_{25}H_{44}$. It is possible to select a number of "nonhomogeneous" mixtures of two different kinds of molecules which will have the above molecular formulas before and after hydrogenation. One such is an equimolal mixture of two kinds of molecules—one kind having the formula $C_{25}H_{34}$, and containing two separate naphthalene nuclei (making four aromatic rings per molecule) together with the appropriate paraffin group or groups, and the other kind having the formula $C_{25}H_{44}$ and containing four naphthene rings per molecule together with the appropriate paraffin group or groups. In 100 molecules of both the "homogeneous" fraction, and the "nonhomogeneous" mixture, there would be 200 aromatic rings (100 naphthalene nuclei) and 200 naphthene rings; and both would have exactly the same molecular formula (an average one for the mixture), $C_{25}H_{34}$, and would show exactly the same increase in the number of hydrogen atoms per molecule (average for the mixture) on hydrogenation. Further, the "homogeneous" fraction and the "nonhomogeneous" mixture would have roughly the same values of density, refractive index, and related properties; but the components of the "nonhomogeneous" mixture would have different values of boiling point and solubility in a given solvent. The important point to be noticed here is that such a "nonhomogeneous" mixture could not be produced by the method of fractionation outlined in Figure 3, for two reasons: (1) The process of systematic distillation would have easily sep-

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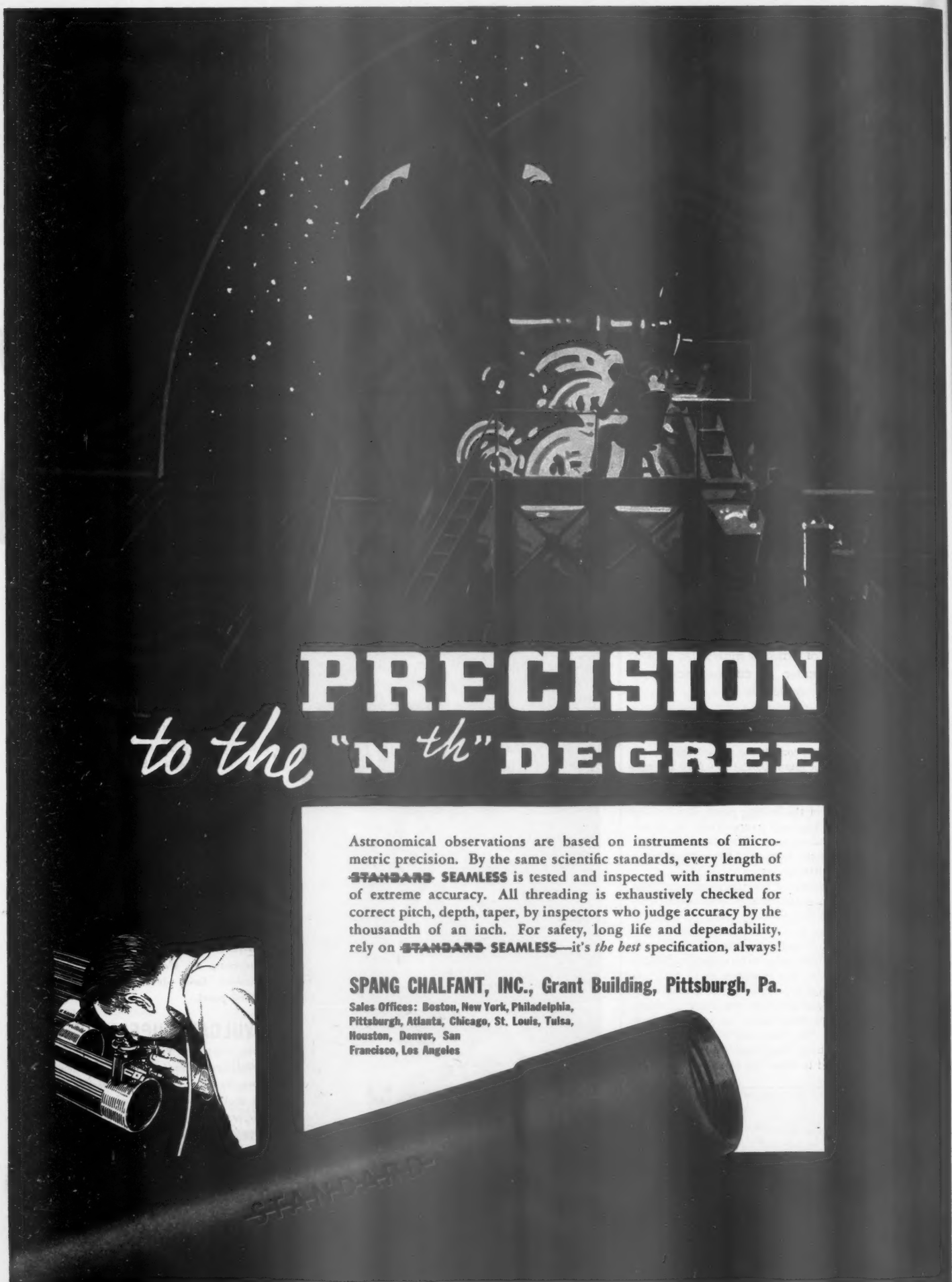

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TABLE 2—EFFECT ON PROPERTIES OF HYDROCARBONS ON CHANGING AROMATIC RINGS TO NAPHTHENE RINGS

(The following values of properties are interpolated from those for actual "homogeneous" fractions)

No.	Molecular formula	No. of naphthene rings (*)	No. of aromatic rings (Condensed)	No. of carbon atoms in paraffin side chains ψ	Boiling point at 1 mm. mercury (°C.)	Kinematic viscosity at 100° F. (Stokes)	Kinematic viscosity at 210° F. (Stokes)	Viscosity index	Refractive index at 25° C. (N_D)	Refractive dispersion at 25° C. ($N_F - N_D$)	Density at 25° C. (grams per milliliter)	Specific refraction $\frac{N^2-1}{N^2+2}\frac{1}{d}$	Specific dispersion $\frac{N_F-N_D}{d}$	Aniline point (°C.)
I (*a*)	$C_{28}H_{38}$	1	3	5	218	90	0.26	—1,600	1.628	0.0298	1.061	0.3345	0.0281	<<0
I (*b*)	$C_{28}H_{30}$	4	0	5	176	3.5	0.10	—300	1.505	0.0106	0.940	0.3155	0.0100	82
II (*a*)	$C_{28}H_{34}$	2	2	7	217	16	0.20	—365	1.573	0.0202	1.004	0.3282	0.0201	6
II (*b*)	$C_{28}H_{44}$	4	0	7	193	3.5	0.12	—150	1.502	0.0093	0.933	0.3163	0.0100	87
III (*a*)	$C_{28}H_{46}$	2	1	14	216	0.83	0.078	35	1.508	0.0114	0.918	0.3247	0.0124	54
III (*b*)	$C_{28}H_{52}$	3	0	14	212	0.76	0.075	40	1.485	0.0089	0.889	0.3224	0.0100	103

*Probably condensed. ψ Calculated on the basis of the naphthene rings being cyclohexyl, condensed together, and condensed with the aromatic rings.

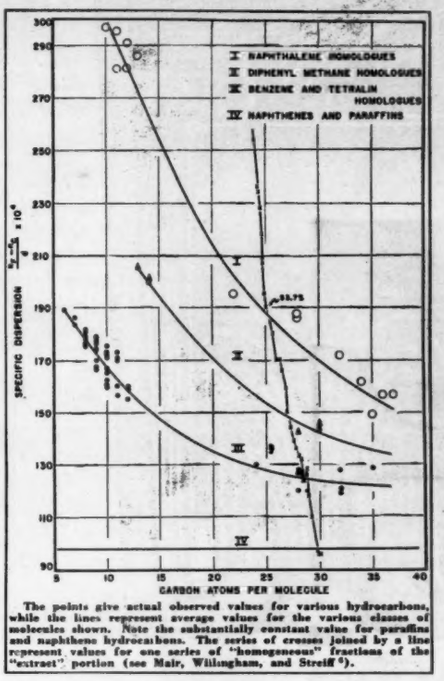
arated the two kinds of molecules in the "nonhomogeneous" mixture, because the 4-ring aromatic molecules would have a higher boiling point than the 4-ring naphthene molecules by over 50° C. at 1 mm. mercury (see Figure 8). (2) The process of extraction would also have separated the 4-ring aromatic molecules from the 4-ring naphthene molecules because of the greater solubility of the former. In a similar way, one may dispose of the possibility of the existence of other "nonhomogeneous" mixtures having all the properties and fulfilling the conditions of preparation of the "homogeneous" fractions.

Figures 8, 9, and 10 show some additional correlation charts, with curves plotted with respect to the percentage extracted (with methyl cyanide) of one of the substantially constant-boiling fractions of the "extract" portion (see Figure 3). Figure 8 gives the boiling point of the fractions before and after hydrogenation (or complete conversion to naphthenes);[5] Figure 9, the kinematic viscosity at 100° F. before and after hydrogenation;[5] Figure 10, the viscosity index before and after hydrogenation.[5]

In identifying the molecules constituting one of the "homogeneous" fractions by comparison of its properties with those of pure hydrocarbons of known structure, it is important to note that while there is a good probability of finding two different molecules, with the same molecular formula, having the same value for one property, there is a practically infinitesimal probability of finding them with five or more different properties of the same value.*

Effect on Properties of Changing Aromatic to Naphthene (Cycloparaffin) Rings

In connection with the data obtained in this work, it is interesting to note the very great differences in the values of the properties of hydrocarbons containing both aromatic and naphthene rings, and the properties of the corresponding molecules with the aromatic rings converted to naphthene (cycloparaffin) rings. Values of properties are shown in Table 2 for hydrocarbons containing



The points give actual observed values for various hydrocarbons, while the lines represent average values for the various classes of molecules shown. Note the substantially constant value for paraffins and naphthene hydrocarbons. The series of crosses joined by a line represent values for one series of "homogeneous" fractions of the "extract" portion (see Mair, Willingham, and Streiff [4]).

Fig. 6—Chart showing the values of the specific dispersion of various molecules plotted against the number of carbon atoms per molecule

paraffin groups attached to the following number and kinds of rings:*

I. (*a*) 1 naphthene ring + 3 aromatic rings (condensed as in anthracene or phenanthrene).
   (*b*) 4 naphthene rings (same structure as I (*a*)).
II. (*a*) 2 naphthene rings + 2 aromatic rings (condensed as in naphthalene).
   (*b*) 4 naphthene rings (same structure as II (*a*)).
III. (*a*) 8 naphthene rings + 1 aromatic ring.
   (*b*) 3 naphthene rings (same structure as III (*a*)).

That is to say, the molecules I (*b*), II (*b*), and III (*b*) are, respectively, the same as I (*a*), II (*a*), and III (*a*) with hydrogen atoms added to the aromatic rings to convert them to naphthene rings. Inasmuch as the number of rings converted from aromatic to naphthene is, respectively, 3, 2, and 1, it would be expected that the greatest change in properties would occur between I (*a*) and I (*b*); next greatest between II (*a*) and II (*b*), with the least change between III (*a*) and III (*b*). It should be noted also that for the molecules I and II about three-fourths of the carbon atoms are in rings, while for molecules III about one-half of the carbon atoms are in rings.

In Table 2 one may notice the great changes in the properties of molecules I (*a*) and I (*b*) in kinematic viscosity at 100° F. from 90 to 3.5 stokes; in viscosity index from —1,600 to —300; in refractive index from 1.628 to 1.505; in density from 1.061 to 0.940; in specific refraction from 0.3343 to 0.3154; in specific dispersion from 0.0281 to 0.0100; in aniline point from << 0° C to 82° C.; and in boiling point from 218° to 176° C. These marked changes in properties on the hydrogenation of the aromatic rings are also illustrated in Figures 8, 9, and 10 for boiling point, kinematic viscosity, and viscosity index, respectively.

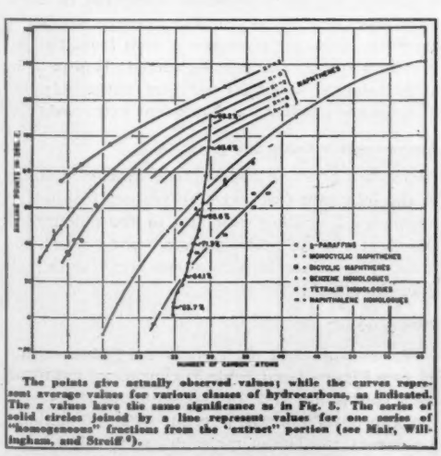
Number and Kind of Hydrocarbons in the Lubricant Fraction

From the data obtained in this investigation (see Mair and others[3-6]) it is possible to make certain conclusions concerning the number and kind of hydrocarbons in the lubricant fraction of the Mid-Continent petroleum studied.

Number of rings per molecule.

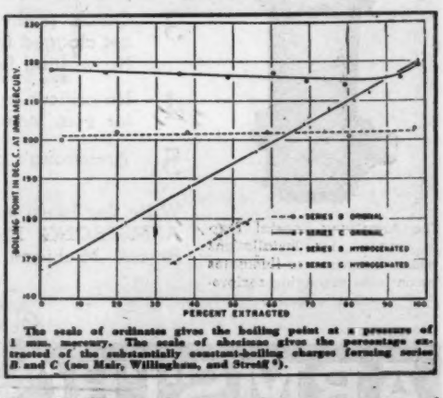
Figure 11 gives a plot* of the number and kind of rings per molecule in the "homogeneous" fractions produced by subjecting to extraction, with methyl cyanide, a substantially constant-boiling fraction of the "extract" portion of the lubricant fraction (see Figure 3). In this plot, it is to be noted that, as one proceeds from the least soluble end toward the most soluble end, the number of aromatic rings increases from 0 to 3 or more—with definite "plateaus" at 1 and 2. At the same time the number of naphthene rings, beginning at the least soluble end, increases quickly to 3, and then drops to 2 at 90 per cent extracted; increases slowly to near 3 at 70 per cent extracted; decreases to 2 at 60 per cent extracted; increases slightly; and then decreases gradually to 1 at 10 per cent extracted. It is interesting to note that from about 70 per cent to 0 per cent extracted the total number of rings per molecule is subsantially constant near 4; and that, in this range, as one proceeds toward the more soluble fractions, naphthene rings are gradually being replaced by aromatic rings. The values plotted in Figure 11 are based upon careful determinations of

*See, for example, Reference 13.



The points give actually observed values; while the curves represent average values for various classes of hydrocarbons, as indicated. The *n* values have the same significance as in Fig. 5. The series of solid circles joined by a line represent values for one series of "homogeneous" fractions from the "extract" portion (see Mair, Willingham, and Streiff [4]).

Fig. 7—Chart showing values of the aniline points for various molecules plotted against the number of carbon atoms per molecule



The scale of ordinates gives the boiling point at a pressure of 1 mm. mercury. The scale of abscissas gives the percentage extracted of the substantially constant-boiling charges forming series B and C (see Mair, Willingham, and Streiff [4]).

Fig. 8—Chart showing, for two series of "homogeneous" fractions of the "extract" portion, the change in boiling point when the aromatic rings in the molecules are changed to naphthenic rings by hydrogenation

*See Reference 4 for details.

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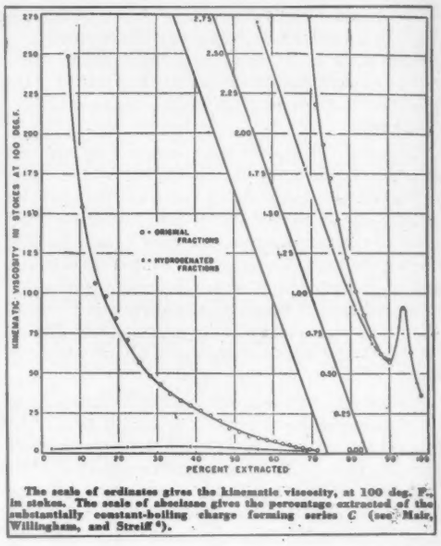
properties, including determination of the aromatic content by hydrogenation with subsequent redetermination of properties, as reported by Mair, Willingham, and Streiff.[4,5,6]

Figure 12 is a plot, with respect to percentage extracted, of the number and kind of rings per molecule in the "homogeneous" fractions produced by subjecting to extraction, with acetone, a substantially constant-boiling fraction of the "water-white" oil portion (see Figure 2). The values plotted in Figure 12 are not as accurate as those of Figure 11, because the amount of aromatic material in this case has been estimated from values of the specific dispersion of about five fractions of the series rather than from the accurate determination, on twice that number of fractions, of the increase in the number of hydrogen atoms per molecule on hydrogenation. Figure 12 shows that, for this series of "homogeneous" fractions of the "water-white" oil, in going from the least soluble end to



The scale of ordinates gives the kinematic viscosity, at 100 deg. F., in stokes. The scale of abscissae gives the percentage extracted of the substantially constant-boiling charge forming series *C* (see Mair, Willingham, and Streiff [6]).

Fig. 9—Chart showing, for one series of "homogeneous" fractions of the "extract" portion, the change in kinematic viscosity when the aromatic rings in the molecules are changed to naphthenic rings by hydrogenation

the most soluble end, the average total number of rings per molecule increases gradually from 1 to 3.2. The average number of naphthene rings per molecule increases from about 1 at 100 per cent extracted to a maximum near 3 at about 25 per cent extracted, and then decreases somewhat to about 2.4 at 0 per cent extracted. The average number of aromatic rings per molecule is zero from 100 per cent to about 25 per cent extracted; begins to be measurable at about 20 per cent extracted; and increases to about 0.8 at 0 per cent extracted.

Approximate average analysis.

Table 3 gives an approximate average analysis of the lubricant fraction with respect to kinds of molecules, including estimates of the amounts in the "water-white" oil, "extract," and "wax" portions. The values in parentheses are less reliable than the others.

"Water-white" oil.

An estimated 92 per cent of the "water-white" oil (see Figure 2 and Table 3) consists of hydrocarbons containing 1, 2, or 3 naphthene rings with the appropriate paraffin groups. The remaining 8 per cent consists of molecules containing 1 aromatic ring together with 1 or 2 naphthene rings and the appropriate paraffin groups. The number of carbon atoms per molecule ranges from about 25 at the low-boiling end to about 40 at the high-

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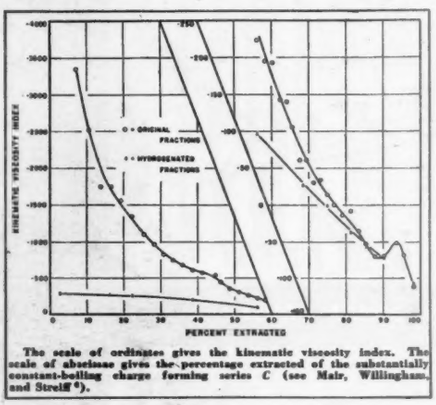
boiling end. In terms of significant amounts, every hydrocarbon in this portion of the lubricant fraction contains one or more naphthene rings.

"Extract" portion.

An estimated 8 per cent of the "extract" portion (see Figure 3 and Table 3) consists of molecules containing 2 or 3 naphthene rings with the appropriate paraffin groups; about 25 per cent of molecules containing 1 aromatic ring together with 2 or 3 naphthene rings and the appropriate paraffin groups; about 37 per cent of molecules containing 2 aromatic and 2 naphthene rings together with the appropriate paraffin groups; and the remainder (30 per cent) of molecules containing 3 aromatic rings and 1 naphthene ring with the appropriate paraffin groups. The number of carbon atoms per molecule ranges from about 20 to 25 at the low-boiling end to about 28 to 36 at the high-boiling end. In terms of significant amounts, every compound in this portion of the lubricant fraction contains one or more naphthene rings.

"Wax" portion.

The so-called "wax" portion (see Figure 1 and Table 3) constitutes 35 per cent of the entire lubricant fraction. This large percentage resulted from the method of dewaxing[1] (with ethylene chloride at —18° C.) which removed, along with the true wax, an appreciable quantity of clear oil because



The scale of ordinates gives the kinematic viscosity index. The scale of abscissae gives the percentage extracted of the substantially constant-boiling charge forming series *C* (see Mair, Willingham, and Streiff[9]).

Fig. 10—Chart showing, for one series of "homogeneous" fractions of the "extract" portion, the change in viscosity index when the aromatic rings in the molecules are changed to naphthenic rings by hydrogenation

of the insolubility of the latter in ethylene chloride at —18° C. Because of the fact that no further separation was performed on the "wax" portion after the first division of the lubricant fraction into four main portions, any conclusions made concerning the constituents other than the well established normal paraffin hydrocarbons must be somewhat speculative. However, considering the several properties previously reported for the unfractionated "wax" portion, together with the recently obtained values of specific refraction and specific dispersion given in Table 4, some limited statements may be made concerning the constitution of this "wax" portion.

As mentioned above, the "wax" portion consists of the true wax plus the clear oil insoluble in the solvent at the dewaxing temperature. The normal (straight-chain) paraffin hydrocarbons are contained in the true wax, which probably contains also some one-ring and two-ring naphthene hydrocarbons having a symmetrical structure.* In this connection there may be pointed out a correlation made of the molecular formulas and freezing points

*As has been pointed out before (see, for example, Table 1 of Reference 10) the freezing point of hydrocarbon molecules is, for a given size of molecule, dependent (among other things) on the symmetry of the molecule, but not on its type; the greater the symmetry of the structure of the molecule, the higher the freezing point.

TABLE 3—APPROXIMATE AVERAGE ANALYSIS OF THE LUBRICANT FRACTION WITH RESPECT TO KINDS OF MOLECULES. (THESE MOLECULES CONTAIN FROM 20 TO 40 CARBON ATOMS.)

Part—	Percentage of lubricant fraction	Molecules composed of the following component parts, with the rings condensed (that is, joined through two carbon atoms) when more than one	Percentage in the given portion‡	Percentage in the entire lubricant fraction‡
"Water-white" oil	35	1 naphthene* ring + paraffin groups	92 (15) (45) (32)	32.2 (5.3) (15.7) (11.2)
		2 naphthene rings + paraffin groups		
		3 naphthene rings + paraffin groups		
"Extract"†	22	1 naphthene ring + 1 aromatic ring + paraffin groups	8	2.8
		2 naphthene rings + 1 aromatic ring + paraffin groups	25	5.5
		2 naphthene rings + paraffin groups	8	1.8
		3 naphthene rings + paraffin groups		
		2 naphthene rings + 2 aromatic rings + paraffin groups	67 (37)	14.7 (8.1)
		3 naphthene rings + 1 aromatic ring + paraffin groups	(30)	(6.6)
		1 naphthene ring + 3 aromatic rings + paraffin groups		
"Wax"	35	1, 2, or 3 naphthene rings + paraffin groups	50 to 25	17 to 9
		Normal paraffins, plus possibly some *iso*paraffins	50 75	18 26
"Asphaltic"	8	(Probably highly condensed multi-ring aromatics, very low in hydrogen, together with the bulk of nonhydrocarbon material of the original lubricant fraction.		

*Cycloparaffin. †Contains also the nonhydrocarbon material discussed above. ‡The values in parentheses are less reliable than the others.

TABLE 4—PROPERTIES OF THE "WAX" PORTION*

	Light end	Lower middle	Upper middle	Heavy end
Refractive index at 50° C. (N_D)	1.4481	1.4526	.....	.....
Refractive dispersion at 50° C. ($N_F - N_C$)	0.00786	0.00797	.....	.....
Density† at 50° C., grams per milliliter	0.8056	0.8152	(0.824)	(0.837)
Specific refraction at 50° C. $\left(\frac{N^2-1}{N^2+2}\right)\frac{1}{d}$	0.3324	0.3313	.....	.....
Specific dispersion at 50° C. $\left(\frac{N_F-N_C}{d}\right)$	0.0098	0.0098	.....	.....
Kinematic viscosity at 150° F., stokes	0.0705	0.0893	0.118	.....
Kinematic viscosity at 210° F., stokes	0.0354	0.0473	0.0555	0.0835

*Values of the kinematic viscosity are taken from Table 2 of Reference 1; values of refractive index, refractive dispersion, and density are unpublished data obtained by B. J. Mair and C. B. Willingham. The four cuts are, respectively, No. 24, 28, 32, and 36 of the 16 cuts (Nos. 23 to 38) constituting the entire "wax" portion.
†Values in parentheses are extrapolated from measurements at 65.5° and 98.8° C.

TABLE 5—PROPERTIES OF THE "ASPHALTIC" PORTION

	Light end*	Heavy end†
Softening point, ‡ § °C.	<25	50
Percentage soluble§ in petroleum ether‖ at about 25° C., per cent	92	62
Refractive index of the part soluble in petroleum ether at about 25° C. (N_D^{25})	1.66	1.67

*Lightest (No. 23) of the total of 16 fractions (Nos. 23 to 38). †Heaviest (No. 37 + No. 38) of the 16 fractions (Nos. 23 to 38). ‡Ring-and-ball method. §Determined by O. G. Strieter. ‖Boiling point of the petroleum ether, 25° to 60° C.

of several waxes, from a Mid-Continent petroleum.[16 17] These data showed that those waxes having the same melting point as the corresponding normal paraffin hydrocarbons had $x = 2$ in the molecular formula C_nH_{2n+x}, which indicated that they were normal paraffins; while those waxes melting about 30° C. lower had $x = 0.5$ in the molecular formula, which indicated the presence, on the average, of about three-fourths of one naphthene ring per molecule in these lower-melting waxes. The foregoing conclusion regarding the presence of naphthene rings in the hydrocarbons of the lower-melting waxes is supported also by values of the specific refraction of these same waxes.†

The "oil" part of the "wax" portion undoubtedly consists of molecules similar to those in the less soluble of the "homogeneous" fractions of the "water-white" oil portion (see Figures 1 and 2 and Table 3) i.e., of one-ring naphthenes, two-ring naphthenes, and three-ring naphthenes. However, the proportion of one-ring naphthenes to three-ring naphthenes would be expected to be somewhat greater in the oil in the "wax" portion than in the "water-white" oil portion because of the small amount of fractionation occurring in the dewaxing process, which would favor slightly the precipitation of the one-ring naphthenes as against the multi-ring naphthenes.

It also appears likely that the entire "wax" portion, including both true wax and oil, contains little or no *iso*paraffins (branched-chain paraffins) in significant amount. It appears that this latter statement may be made because, if there were *iso*paraffins in the original lubricant fraction, some of the less symmetrical ones would have become part of the "water-white" oil portion, and no *iso*paraffins in significant amount were found in the latter material.[3] Furthermore, the lower-melting waxes have been shown to be naphthene hydrocarbons, rather than *iso*paraffins.[3 16 17 23]

Table 4 contains values of the refractive index, refractive dispersion, density, specific refraction, specific dispersion, and kinematic viscosity for several of the 16 fractions constituting the "wax" portion of the original lubricant fraction (see Figure 1 of this paper and Table 2 of Reference 1). The values of the specific dispersion show that the entire "wax" portion is substantially free of aromatic hydrocarbons. The values of the specific refraction indicate that the *entire* "wax" portion contains, on the average, about 0.6 to 0.8 of a naphthene ring per molecule. Assuming that in the naphthene molecules alone there will be, on the average, from 1.5 to 2.5 rings per molecule and, further, that *iso*paraffins are absent, then it may be estimated that in the entire "wax" portion the proportion of molecules will be in the range from 50 per cent normal paraffins (plus possibly some *iso*paraffins) and 50 per cent naphthenes to 75 per cent normal paraffins (plus possibly some *iso*paraffins) and 25 per cent naphthenes (the naphthenes having, of course, their appropriate side chains).

"Asphaltic" portion.

In regard to the "asphaltic" portion of this lubricant fraction (see Figure 1) no further separation was performed. On the lightest and heaviest fractions of this material there was determined the softening point, the solubility in petroleum ether at room temperature, and the refractive index of the material soluble in petroleum ether at room temperature. These data have been reported by Mair, Will-

†These can be calculated from the data given in Reference 16.

ingham, and Streiff,[4] and are reproduced here in Table 5. From these few properties, together with the processes of separation involved, it is apparent that this material is probably composed of molecules with highly condensed aromatic nuclei and few or no naphthene (cycloparaffin) rings or paraffin groups, and containing all of the sulfur and nitrogen of the original lubricant fraction except that which was found in the "extract" portion.

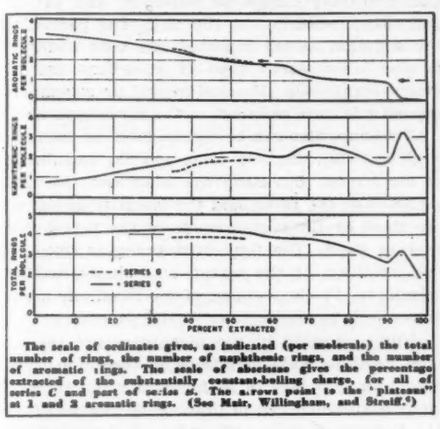
Summary of analysis.

Taking the lubricant fraction as 100 per cent, the values given in the last column of Table 3 lead to the following summary:

1. About 43 to 51 per cent of the lubricant fraction is composed of molecules with 1, 2, or 3 naphthene rings, together with the appropriate paraffin side chains.

2. About 8.3 per cent is composed of molecules with 1, 2, or 3 naphthene rings and 1 aromatic ring, together with the appropriate paraffin side chains.

3. About 8.1 per cent is composed of molecules with 2 naphthene rings and 2 aromatic rings (condensed) together with the appropriate paraffin side chains.



The scale of ordinates gives, as indicated (per molecule) the total number of rings, the number of naphthenic rings, and the number of aromatic rings. The scale of abscissae gives the percentage extracted of the substantially constant-boiling charge, for all of series *C* and part of series *B*. The arrows point to the "plateaus" at 1 and 2 aromatic rings. (See Mair, Willingham, and Streiff.[4])

Fig. 11—Chart showing the number of rings per molecule for one series (and part of another) of "homogeneous" fractions of the "extract" portion

4. About 6.6 per cent is composed of molecules with 1 naphthene ring and 3 aromatic rings (condensed) together with the appropriate paraffin side chains.

5. About 18 to 26 per cent is composed of normal (straight-chain) paraffins, plus possibly some *iso*-paraffins (branched-chain).

6. About 8 per cent is composed of "asphaltic" constituents.

Conclusion

From the work which has so far been completed on the lubricant fraction of a Mid-Continent petroleum by A.P.I. Research Project 6, the following points may be noted:

1. A complete analysis with respect to size and type of molecules has been made on both the "water-white" oil and "extract" portions, which together constitute about 57 per cent of the entire lubricant fraction. In terms of significant amounts, every hydrocarbon in these two portions contains one or more naphthene rings, which is to say that there are no purely paraffinic or aromatic hydrocarbons in these portions.

2. The kind of molecules in the "wax" portion, which constitutes about 35 per cent of the lubricant fraction, is known in a general way, but much less definitely than those of the "water-white" oil and "extract" portion.

3. The kind of molecules in the "asphaltic" portion, which constitutes about 8 per cent of the lubricant fraction, are surmised.

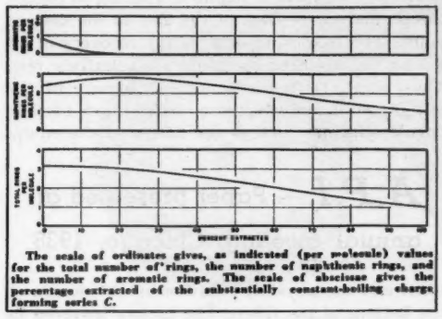
With regard to current and future work on the lubricant fraction by this project, the following points may be made:

1. An effort toward the separation of pure hydrocarbons from a large quantity of the dewaxed lubricant fraction of a second Mid-Continent petroleum is under way.

2. The "wax" and "asphaltic" portions discussed in the present report are now in "storage," but some further work on these portions undoubtedly would be desirable.

In connection with the technological and scientific applications which may be made of the information already gained on the lubricant fraction of petroleum, the following points may be considered:

1. The knowledge obtained will aid and give impetus to the industry's problem of producing, from the lubricant fraction of petroleum, materials of special properties which better can fill the mod



The scale of ordinates gives, as indicated (per molecule) values for the total number of rings, the number of naphthenic rings, and the number of aromatic rings. The scale of abscissae gives the percentage extracted of the substantially constant-boiling charge forming series *C*.

Fig. 12—Chart showing the number of rings per molecule for one series of "homogeneous" fractions of the "water-white" oil portion

ern requirements arising from the need for greater efficiency, higher speeds, and more concentrated power, and the use of high pressures and high and low temperatures.

2. The results obtained will aid in the problem of producing lubricating and other oils synthetically, because the knowledge of what kinds of molecules are in lubricating oil from petroleum can help decide what molecules should be synthesized, and because of the knowledge of the method and extent of separation, and of the properties, will be useful in producing "homogeneous" synthetic materials and in identifying the constituents.

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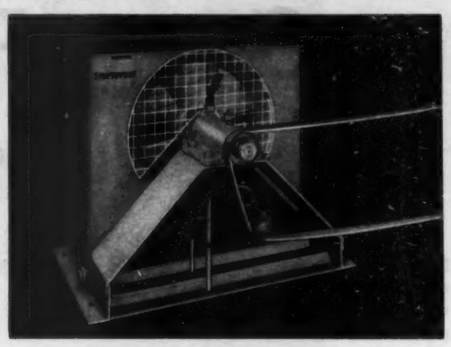

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Study of Recovery of Oil From Spent Percolation Filters

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The percolation filtration process for decolorizing petroleum products is potentially a low-cost process. In general, the greater part of the manufacturing cost comprises items of expense other than the adsorbent. For this reason a considerable change in the decolorization cost may be made with only slight modifications of the operating procedure.

It is the purpose of this paper to present data on one of the important factors influencing percolation filtration costs, viz., the recovery of the oil remaining in the filter when the adsorbent is spent.

In conducting the percolation process the adsorbent in the newly-charged filter is soaked with oil until the voids between the grains of adsorbent are filled and the adsorbent is completely saturated. In as much as the filter will contain at the end of the run an amount of oil equivalent to the soak, it is evident that, regardless of the yields of filtered specification oil recovered from the filter, the amount of oil retained in the filter at the end of each filter turnover is the same. The economical recovery of the soak has an important bearing on both yields and process costs. There is an additional consideration in recovering oil from percolation filters, viz., the maximum amount of oil that can be left in the adsorbent without interfering with the successful revivification of the spent adsorbent. Experimental data accumulated by this company indicate that the amount of oil remaining in fuller's earth has no effect upon the efficiency of the revived adsorbent, provided the burning operation is so conducted that excessive temperatures are avoided and the carbonaceous matter is completely removed. It has been generally accepted in the industry, however, that the fuller's earth returned to the burner should not have an oil content greater than 2.5 per cent by weight of the clay, and our experience indicates this figure to be a satisfactory operating guide.

The general procedure in recovering oil involves draining the filter and washing with naphtha. In as much as draining alone does not suffice to remove the oil adequately from the clay, it is necessary to resort to naphtha washing to reduce the oil and tar content of the clay to the desired point. The factors influencing the recovery of oil during the draining operation are relatively few. They are: (1) Temperature; (2) nature of the oil; (3) mass and mesh size of clay; and, (4) mechanical factors such as the design of the equipment and the physical condition of the screen at the bottom of the filter. The factors involved in washing with naphtha consist of: (1) The wash liquor; (2) nature of the oil; (3) the adsorbent; and (4) physical factors such as temperature, rate and design of the filter. While various washing methods have been tried and proposed, the most practical appears to be that of naphtha washing. If we assume that the spent adsorbent must be washed until only 2½ per cent by weight of oil remains in the filter, the minimum amount of wash is fixed for a given filter. The quantity, it is reasonable to expect, will vary with the adsorbent and the type of oil being processed. For practical consideration the net oil contained in a spent filter is classified as follows: (1) Drainings; (2) filterable clay-wash stock recovered from the clay wash; (3) stock contained in the clay wash that profitably cannot be refiltered, and (4) oil and color bodies lost to the clay. The particular investigation herein reported has been confined to the fuller's-earth type of adsorbent and to Pennsylvania oils. No acid-treated or solvent-extracted oils were included in the investigation.

A.P.I.— Paper presented at annual meeting, Chicago, 1938

Two variables can be manipulated in draining a given filter, viz., (1) time, and (2) cleanliness of the screen. Obviously the adsorbent, the temperature of the filter, and the viscosity of the oil are fixed by the requirements of the percolation process itself. The time of draining is fixed by the condition of the screen and plant-operating schedules. The importance of the condition of the screen will be shown later in the paper.

Filter washing in the plant does not readily lend itself to wide variations in operation. The only four variables in so far as a given filter is concerned which can in practice be changed are: (1) Volume of wash; (2) rate; (3) temperature, and (4) type of naphtha. The volume of wash is determined by the oil recovery desired. Our experience has indicated that it is best to add wash naphtha slowly to the drained filter to avoid mixing. Once the filter has been filled with wash naphtha, additional naphtha should be charged at a low and uniform rate which is somewhat comparable to the original filtration rate. High washing rates may result in excessive channeling, which naturally must be avoided.

Due to the large quantity of clay and oil in the filter, casual consideration might lead to the thought that the initial temperature of the naphtha would not have an appreciable effect on the washing operation. This warrants further consideration, however, for the reason that the concentration of adsorbed tar is greatest in the top layers of the filter. Therefore, it is possible that the temperature of the incoming naphtha may have a significant effect on the washing operation. An attempt was made to study this variable on solution filters; and, while the other variable of rate was not under particularly good control,

TABLE 1—PHYSICAL CHARACTERISTICS OF THE OILS

Type of oil—	Gravity (°A.P.I.)	Viscosity, Saybolt Universal, at 100° F.	Viscosity, Saybolt Universal, at 210° F.	Color (N.P.A.)
85 neutral	33.6	80	..	1½
150 neutral	31.3	150	43	2+
280 neutral	30.2	276	52	+5
Bright stock	26.2	...	148	+8

TABLE 2—SOAKAGE, DRAINING AND CLAY-RETENTION DATA

(Barrels per ton of clay)

Stock—	85 neutral	150 neutral	280 neutral	Bright stock
Soakage, net oil	9.33	9.42	9.08	8.98
Drainings, net oil	4.10	3.90	3.53	3.53
Clay retention, net oil	5.23	5.52	5.55	5.45

Note: All filters (except those in which undiluted bright stock was used) were soaked, drained, and washed at 130° F. The bright-stock filters were soaked and drained at 200° F., and washed with naphtha at 130° F.

TABLE 3—EFFECT OF OIL VISCOSITY ON WASHING PERCOLATION FILTERS

Distribution of Net Viscous Oil (Barrels Per Ton)

Stock:	85 Neutral				150 Neutral				280 Neutral				Bright Stock			
Wash number increment (1 bbl. per ton)	In wash		Wash plus drainings	On clay	In wash		Wash plus drainings	On clay	In wash		Wash plus drainings	On clay	In wash		Wash plus drainings	On clay
	Increment	Accumulative			Increment	Accumulative			Increment	Accumulative			Increment	Accumulative		
1	1.00	1.00	5.10	4.23	1.00	1.00	4.90	4.52	1.00	1.00	4.53	4.55	1.00	1.00	4.53	4.45
2	1.00	2.00	6.10	3.23	1.00	2.00	5.90	3.52	1.00	2.00	5.53	3.55	0.925	1.93	5.46	3.52
3	1.00	3.00	7.10	2.23	1.00	3.00	6.90	2.52	1.00	3.00	6.53	2.55	0.738	2.66	6.19	2.79
4	0.930	3.93	8.03	1.30	0.976	3.97	7.87	1.55	0.915	3.92	7.45	1.63	0.680	3.34	6.87	2.11
5	0.571	4.50	8.60	0.73	0.621	4.60	8.50	0.92	0.636	4.55	8.08	1.00	0.546	3.88	7.41	1.57
6	0.240	4.74	8.84	0.49	0.364	4.96	8.86	0.56	0.426	4.98	8.51	0.57	0.378	4.26	7.79	1.19
7	0.146	4.89	8.99	0.34	0.162	5.12	9.02	0.40	0.174	5.15	8.68	0.40	0.271	4.54	8.03	0.94
8	0.100	4.99	9.09	0.24	0.10	5.22	9.12	0.30	0.088	5.24	8.77	0.31	0.093	4.63	8.16	0.81
9	0.052	5.04	9.14	0.19	0.064	5.29	9.19	0.23	0.050	5.29	8.82	0.26	0.078	4.71	8.24	0.74
10	0.040	5.08	9.18	0.15	0.052	5.34	9.24	0.18	0.046	5.34	8.87	0.21	0.055	4.76	8.29	0.69
11	0.036	5.12	9.22	0.11	0.038	5.38	9.28	0.14	0.036	5.37	8.90	0.18	0.052	4.81	8.34	0.64
12	0.033	5.15	9.25	0.08	0.033	5.41	9.31	0.11	0.033	5.40	8.93	0.15	0.048	4.86	8.39	0.59
13	0.023	5.17	9.27	0.06	0.024	5.43	9.33	0.09	0.021	5.42	8.95	0.13	0.048	4.91	8.44	0.54
14	0.019	5.19	9.29	0.04	0.019	5.45	9.35	0.07	0.019	5.44	8.97	0.11	0.036	4.94	8.47	0.51
15	0.010	5.20	9.30	0.03	0.019	5.47	9.37	0.05	0.017	5.46	8.99	0.09	0.033	4.97	8.50	0.48

Note: All filters washed with Sharples naphtha heated to 130° F.

it became apparent that the temperature of the naphtha actually does seem to play a fairly important part in so far as the color of the cylinder stock recovered in the wash is concerned. It would appear, therefore, that the proper procedure would be first to use sufficient cold naphtha to replace the drainings and insure removal of a greater portion of the retained oil at a temperature level at or below the filtration temperature. Hot naphtha should then be used to assist in removing the balance of the oil and coloring matter.

The ideal wash naphtha would be one possessing a low vapor pressure to minimize handling loss, and a low final boiling point to decrease naphtha retention by the clay during the steaming operation and to decrease the cost of separating the naphtha from the recovered oil. Furthermore, the wash used to remove the good oil should not dissolve tar and polymerization products. Following the removal of the good oil, the filter should then be washed with a fluid possessing a high solvent power for the tar and polymerization products—thus cleaning the clay. Practical considerations generally enforce the use of a single naphtha having a fairly low tolerance for tar and polymerization products. Some control of its solvent power can be had by manipulation of the temperature. While we are unable at this time to present precise data, our information and that obtained from other sources indicate that a highly-paraffinic naphtha is desirable.

The nature of the oil present in the filter has an important bearing upon the draining and washing operations. It would seem that the viscosity, adhesion tension, and surface tension of the oils are the physical characteristics having the greatest influence on these steps of the operation. In as much as the differences in surface tension of mineral oils are slight, and because data on adhesion tension and methods of measuring it are uncertain, no efforts were made to evaluate the specific influences of these characteristics on filter draining and washing. From a practical standpoint, the response of oils of different viscosity to filter draining and washing is important; hence, Pennsylvania oils of different viscosities were investigated—and, while it is not certain that viscosity was the only variable, an effort was made to minimize differences in surface and adhesion tension by using, in these experiments, filtered oil. The inspection data of the respective oils are shown in Table 1.

The effect of viscosity on soakage, draining, and oil retention is illustrated by the data obtained on these oils, and reported in Table 2. In this particular set of experiments it may be observed that the relative amount of drainings decreases slightly as the viscosity increases.

The effectiveness of naphtha in removing oils from clay and the extent of the washing required to reduce the oil content of the clay to 2½ per cent are shown in Table 3 and Figure 1. It is apparent that the viscosity of the oil is important in the early stage of the washing operation. The practical significance of this is dependent upon the amount of clay-wash stock that can be returned for refiltering. It is to be observed that, as the amount of wash increases, the effectiveness of viscosity decreases for all stocks except bright stocks. The effect of viscosity has been evaluated with respect to the amount of naphtha required to decrease the oil content of the clay to 2½ per cent by weight. These results lead to the following estimates:

Stock—	Bbls. of naphtha per ton of clay required to give 2½ % oil
85 neutral	10.3
150 neutral	10.6
280 neutral	11.6

In the case of bright stock it was observed that up to 15 bbls. naphtha per ton were insufficient

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to lower the oil content below 7.6 per cent. By reference to Figure 1, it may be seen that the amount of naphtha required to reduce the bright-stock content of the clay to 2.5 per cent would be very great.

In as much as the major load at the average refinery filter plant consists of cylinder stocks and similar oils in naphtha solution, this paper will be devoted primarily to filters used in solution filtration.

Plant Experimental Data

A study was made of the soaking, draining, and washing of Pennsylvania cylinder-stock solution filters in a plant equipped with filters having a nominal capacity of 35 tons of fuller's earth. These filters are 10 feet in diameter by 25 feet high, and are equipped with Fulton heads. In this plant the soaking operation involves slowly adding oil to the filter under conditions permitting free displacement of the air. As soon as the vessel is full, it is permitted to stand until the clay —a 16- to 30-mesh Florida fuller's earth—is saturated. The clay is delivered to the filters at a temperature of approximately 120° F., and the oil is charged to the soaking operation at a temperature of 130° F. A representative mesh analysis and other pertinent tests of the clay are given in Table 4.

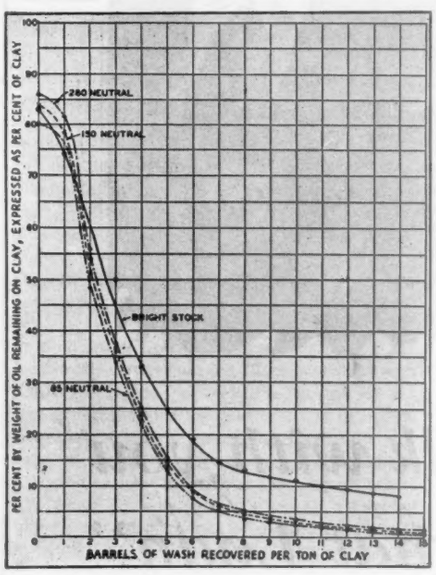
PER CENT BY WEIGHT OF OIL REMAINING ON CLAY, EXPRESSED AS PER CENT OF CLAY
280 NEUTRAL
150 NEUTRAL
BRIGHT STOCK
65 NEUTRAL
BARRELS OF WASH RECOVERED PER TON OF CLAY

Fig. 1—Oil remaining on clay vs. number of barrels of wash

TABLE 4—PHYSICAL CHARACTERISTICS OF THE CLAY

Mesh	Per cent
0-16	0.3
16-30	85.7
30-60	13.6
60-100	0.2
100+	0.2

Loss on ignition (Per cent)		Weight of un packed clay after burning (Lbs. per cu. ft.)
As received	17.1	30.8
After burning	5.5	...

The typical inspections of the solution and its components are shown in Table 5. The quantity of oil required to soak the filter varies somewhat from plant to plant. In our particular case the soakage amounts to about 7.5 bbls. of solution per ton of fuller's earth. As indicated previously in this paper, the factors influencing the drainage are: (1) Temperature; (2) mass and mesh size of the clay; (3) nature of the oil; (4) time; and (5) mechanical factors. Temperature, mass, and mesh size of the clay and the nature of the oil are set by demands of the filtration operation. Consequently, there is no control over these factors in the draining operation. The importance of time and mechanical factors were studied on the 35-ton filters mentioned above. The resultant data are presented in graphical form in Figures 2 and 3. With clean screens it can be seen that there is little recovery of solution after the fourth hour, and that the flow from the filter practically ceases by the end of the sixth hour; while under average conditions the rate decreases to approximately the same figure at the end of the eighth hour. It is also obvious that the rate of draining and the accumulative drainings decrease as the screen fouls. An appreciable saving in time can be made by using clean screens and adequate rundown lines. The draining rate of the filter should be kept under close observation, so that an adequate recovery of oils during the draining period is realized without undue expenditure of time.

The discussion of washing-solution filters will be confined to those handling blends of Pennsylvania cylinder stock and Sharples naphtha. In the washing of a filter with naphtha, two procedures may be followed: Viz. (1) displacement washing, in which the filter is not drained but in which an attempt is made to recover the oil—normally removed by draining—by displacing it with fresh naphtha; (2) draining and washing, wherein the filter is drained and then washed to remove the balance of the solution. In this paper we shall discuss the second procedure. Theoretical considerations indicate that downward washings should be used, in as much as the wash liquor has a lower density than the oil being removed. This procedure lessens the tendency toward mixing due to convection. Consequently, downward washing only is being considered. In so far as the drained filter is concerned, the amount of solution held between the clay particles for a given unit of clay increases from the top of the filter to the bottom. At some point above the screen the voids frequently are filled with solution, due to partial clogging of the screen and the lack of sufficient hydrostatic head to force the solution through the screen in a reasonable length of time. Likewise, the concentration of solution in a given horizontal plane with respect to its distance from the center of the filter may be different, due to the tendency of the larger granules of adsorbent to find their way to the side of the filter when

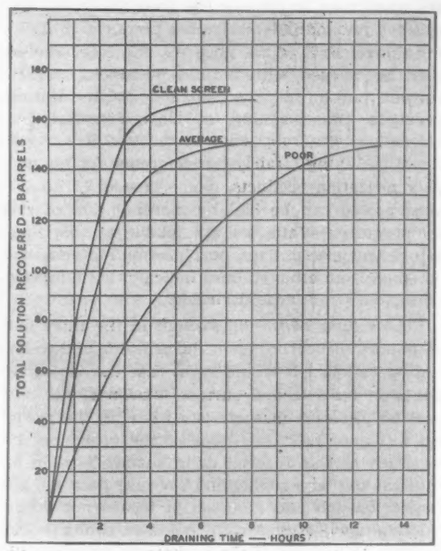

Fig. 2—Accumulative draining vs. time for 35-ton filter

TABLE 5—WASHING DATA OBTAINED WHILE USING FRESH NAPHTHA

Sample taken after—	Elapsed time (min.)	Temp., °F. Naphtha to filter	Temp., °F. Naphtha rundown tank	Solution data Color N.P.A.	Color True	Color OD*	Gravity (Deg. A.P.I.)	Stock (Per cent by volume)	Denuded oil Color True	Denuded oil Color OD*	Gravity (Deg. A.P.I.)	Conradson carbon (Per cent)	Viscosity at 210 °F. (Seconds)	Filter yields of net oil (Bbls. per ton) Color 6 N.P.A.	Color 7 N.P.A.	Color 8 N.P.A.
1 bbl. per ton per wash	30	74	106	5D †	350	680	44.8	37.1	1,200	2,270	26.1	1.6	149	9.9	12.0	13.5
2 bbls. per ton per wash	45	74	108	5D	350	766	44.8	37.1	1,200	2,430	26.1	1.9	149	9.3	11.2	12.7
3 bbls. per ton per wash	60	74	108	+5D	300	749	48.6	25.7	1,600	2,990	25.9	2.4	162	8.6	10.6	12.0
4 bbls. per ton per wash	80	72	110	4½D	270	573	51.9	16.6	2,000	3,390	25.7	2.2	156	6.7	7.5	9.2
5 bbls. per ton per wash	95	126	84	4+D	230	347	53.0	13.7	2,000	3,180	25.6	2.4	157	6.4	7.5	9.0
6 bbls. per ton per wash	110	126	112	8	190	347	53.3	12.9	2,000	3,390	25.7	2.4	155	...	...	...
7 bbls. per ton per wash	125	123	112	+8	170	290	54.1	10.7	1,800	3,320	24.6	2.5	168	..	...	...
8 bbls. per ton per wash	135	123	110	7+	150	267	54.2	10.3	1,600	3,280	24.1	2.7	153	..	...	...
9 bbls. per ton per wash	150	123	108	7+	150	212	55.4	7.0	2,000	3,390	25.3	2.7	154	..	...	...
10 bbls. per ton per wash	162	128	106	6	88	152	56.3	5.1	1,800	3,560	25.3	2.3	153	..	...	...
11 bbls. per ton per wash	177	130	106	+6	80	144	56.6	2.8	2,000	4,070	25.2	2.5	157	..	...	...
Eureka cylinder stock	...	...	...	...	...	...	...	...	3,000	5,500	25.9	2.2	152	9.2	11.7	13.4
Fresh raw Eureka solution	...	...	...	3+DD ‡	750	1,615	44.9	36.4	2,900	5,620	26.0	2.2	152	9.7	11.7	13.1
Composite filter drainings	...	...	...	5D	350	668	44.7	37.1	1,000	2,170	26.1	1.7	145	9.7	12.0	13.5
Composite wash to blend tank	...	...	...	½+D	310	562	47.4	29.0	1,600	3,430	26.2	2.9	149	9.2	10.7	12.2
Composite wash to storage	...	...	...	+8	170	290	54.4	9.8	1,100	2,210	25.6	2.1	148	6.2	7.3	8.6
Steaming stop to stills	...	...	...	6	88	144	57.1	2.7	3,500	5,930	24.6	3.7	173	..	...	...
Sharples naphtha used for wash	...	...	...	...	...	...	58.2									

A.S.T.M. Distillation in Deg. F.

Initial boiling point	200
5 per cent point	230
10 per cent point	240
20 per cent point	250
30 per cent point	260
40 per cent point	270
50 per cent point	280
60 per cent point	290
70 per cent point	302
80 per cent point	314
90 per cent point	334
95 per cent point	348
Endpoint	372

Notes: Cuts 1 to 4, inclusive, were returned to the blend tank. Cuts 5 to 11, inclusive, were pumped to clay-wash storage. Oil content of clay following steaming, 1.1 per cent. Soakage, 260 bbls. Drainage, 145 bbls. Wash naphtha, 530 bbls. *Optical density. †Dilute. ‡Double dilute.

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the filter is charged with adsorbent. Hence, the concentration of solution may be greater in the center, because capillary attraction will tend to hold more solution in the voids between small grains in the center than in the case of the larger grains at the filter walls. Our concept of the mechanics of the washing step is somewhat as follows: As the naphtha enters the filter, it first displaces the oil-naphtha solution remaining between the particles of clay and flows downward toward the screen. Some mixing occurs as the mixture of naphtha solution flows downward, but the first increment of naphtha will contain progressively more and more solution as it works its way down through the clay. The solution-enriched naphtha, therefore, reaches the point where it begins to displace the solution held in the voids at the bottom of the filter. It, therefore, appears that the first portion of the wash recovered from the filter will be solution having substantially the same composition as the charge to the filters, and that the second portion of the wash will have an oil concentration but slightly less than this—but the stock content in successive increments must decrease. If we now consider a horizontal plane located at any point in the filter, it will be seen that the first increment of wash passing through this portion of the clay will remove the oil held in the voids of the clay. Once this material is removed, it begins to scrub the surface of the clay. Simultaneously, some of the solution retained in the pores of the clay may diffuse outwardly into the naphtha. The film of unpolymerized cylinder stock would be removed, and the tar and polymerization products should dissolve to a greater or lesser extent. It is quite likely that the tar and polymerization products also hold mechanically some occluded cylinder stock. As washing progresses under these conditions, the amount of cylinder stock contained in the wash will steadily decrease, because mixing and diffusion occur. Likewise, the ratio of good oil to redissolved color bodies should decrease.

In as much as a uniform distribution of adsorbent according to grain size and a similar concentration of solution in any horizontal plane may not be realized, all of the clay in this plane may not be simultaneously experiencing the same portion of the washing cycle. Under these conditions mixing of tar and polymerization products with the good oil may occur early in the washing cycle.

A primary object of the washing step is to reclaim a maximum amount of the oil having a filterability comparable to the raw cylinder stock. It is desirable so to control the procedure that the portion of wash returned for further filtration is rich in recovered cylinder stock, and not diluted with naphtha to the point where it will interfere with the filtration and dewaxing operations. Furthermore, the balance of the washing operation, which is conducted for the purpose of decreasing the oil and tar content of the clay to 2.5 per cent, should be so conducted that the volume of wash requiring redistillation is kept to a minimum.

In an effort to study the washing operation, plant and experimental data were accumulated with a view to evaluating the various factors dis-

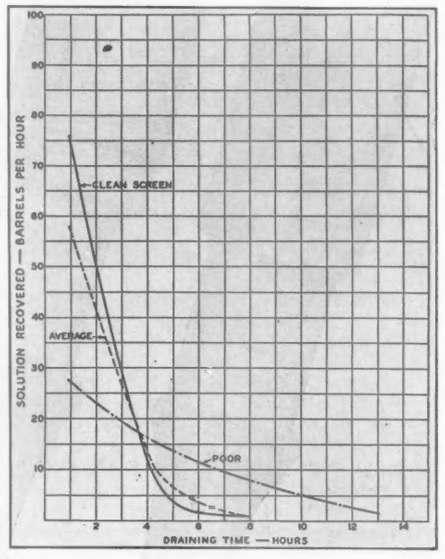
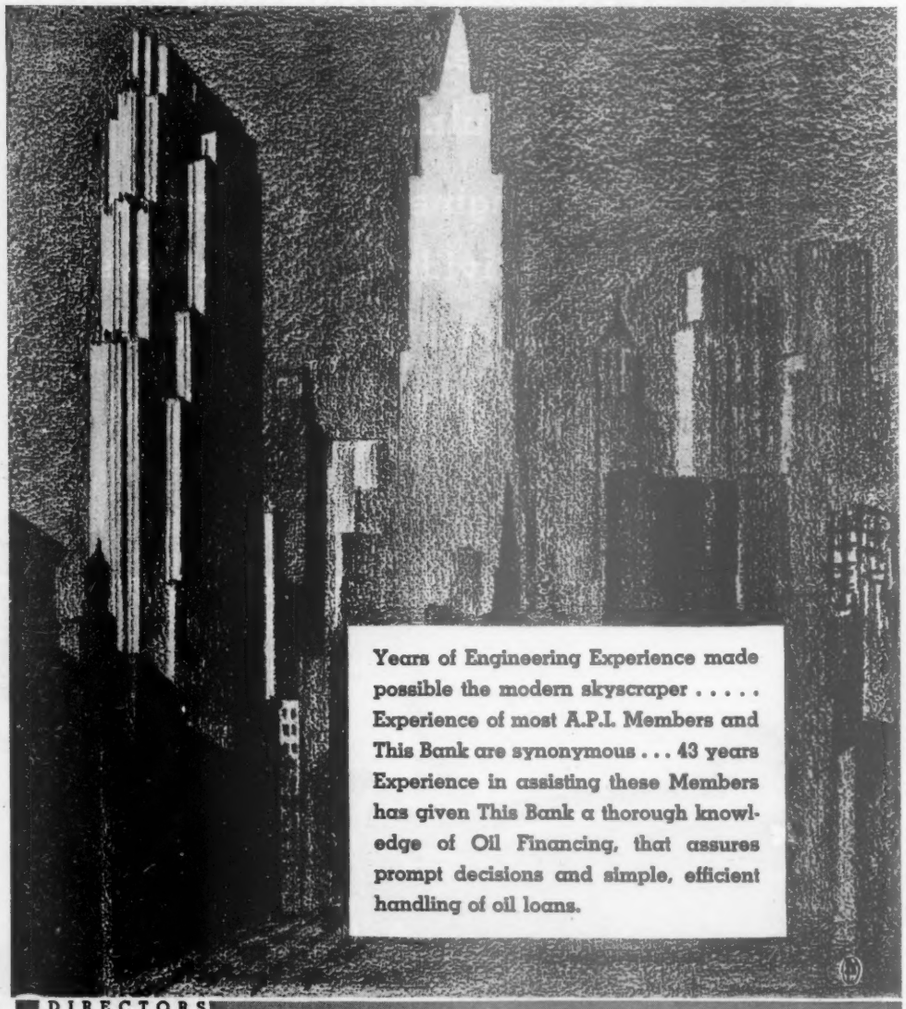


Fig. 3—Draining rate vs. time for 35-ton filter

cussed above. Experimental runs were made on a 35-ton filter handling Pennsylvania cylinder-stock solution. Samples were taken representing increments of 1 bbl. per ton of recovered wash. The color, A.P.I. gravity, and stock content of the solutions were determined. These samples were then denuded of naphtha in the laboratory, and the A.P.I. gravity, color, viscosity, and carbon residue were determined on the net oil. In addition, samples of the net oil were rediluted with Sharples naphtha to the same concentration used in plant filtration work, and the filter yields to various N.P.A. colors were determined in the laboratory. These data on a typical run, along with the essential information regarding the cylinder stock, naphtha, drainings, etc., are presented in Table 5. For a complete understanding of this table, it may be well to explain that the true colors referred to therein were determined according to the method described by Weir, Haughton, and Majewski.[1] The OD colors, or so-called optical-density colors, are described by Ferris and McIlvain.[2] These color units are included in this report, in as much as they are more or less additive.

At the time the eleventh barrel per ton of wash was recovered, the filter was full of naphtha,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which was recovered in the subsequent steaming operation. In this particular run the filter was washed with 530 bbls. of fresh naphtha, or 15.2 bbls. per ton of clay. In as much as the filter was soaked with 260 bbls. of solution and 145 bbls. of drainings were recovered, the recovered wash and steamings amounted to approximately 645 bbls., or 18.4 bbls. per ton of clay. The first 4 bbls. of recovered wash per ton of clay were returned to the cylinder-stock-solution blend tank, and the next 7 bbls. of recovered wash per ton of clay were pumped to clay-wash storage. The filter was steamed at this point; and some 260 bbls., or 7.4 bbls. per ton, were recovered as steaming slop. The steamed clay contained 1.1 per cent by weight of oil.

The data in Table 5 permit calculation of the oil content of the clay after the application of each increment of wash. The results of such a series of calculations are presented in Figure 7. It is to be observed that the first few increments of wash lowered the oil content of the clay appreciably, but that the increments following the seventh were not as effective. A comparison of the bright-stock data in Figure 1 with those in Figure 7 illustrates the effect of naphtha dilution on the recovery of oil from spent clay. This comparison is believed to be valid, in as much as laboratory filter-washing data accumulated to date appear to check the plant data reasonably well.

Figure 7 indicates that the oil content of the clay following the use of 11 bbls. of naphtha per ton of clay was 4.2 per cent by weight of the clay. However, the steamed clay contained but 1.1 per cent oil; consequently, the removal of oil from the clay during the steaming operation must be taken into consideration when washing a filter for the purpose of preparing the clay for revivification.

A portion of the experimental data showing the change in OD color, Conradson carbon residue, and the per cent of the cylinder stock in the wash has been plotted against the barrels of recovered wash in Figures 4 and 5. While the data presented in Figure 4 are of considerable interest,

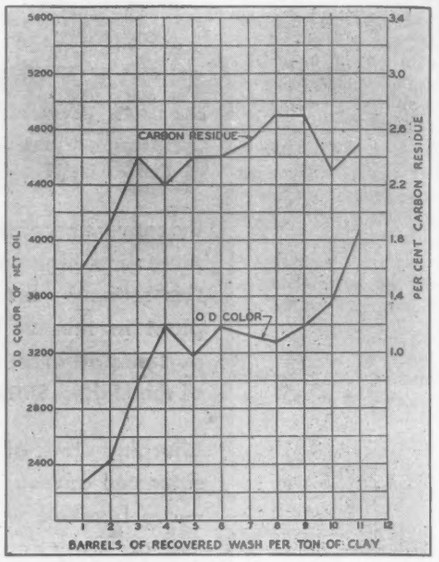

Fig. 4—Carbon residue and OD color of cylinder stock in recovered wash

they do not touch upon one of the most important points, viz., the filterability of the recovered oil. Data on this important factor are plotted in Figure 6. The information contained in Figure 6 emphasizes the importance of controlling the amount of washings that are returned to the blend tanks for re-processing. Table 5 clearly shows that the color of the net stock does not adequately determine its filterability. It is not uncommon in plant practice to determine the point at which the filter wash is cut out of the blend tank by means of the color of the solution. Our data indicate that this practice cannot be de-

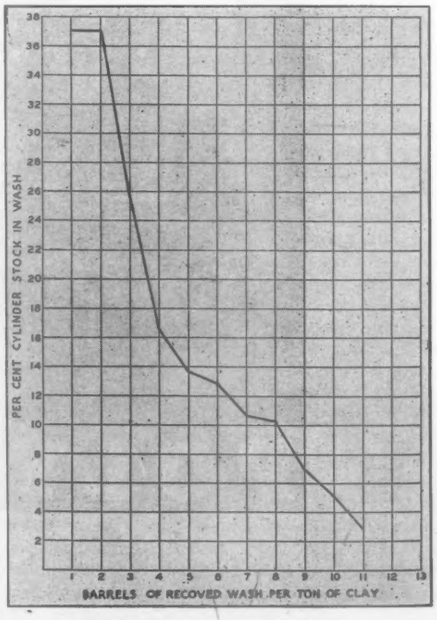

Fig. 5—Concentration of cylinder stock per increment of recovered wash

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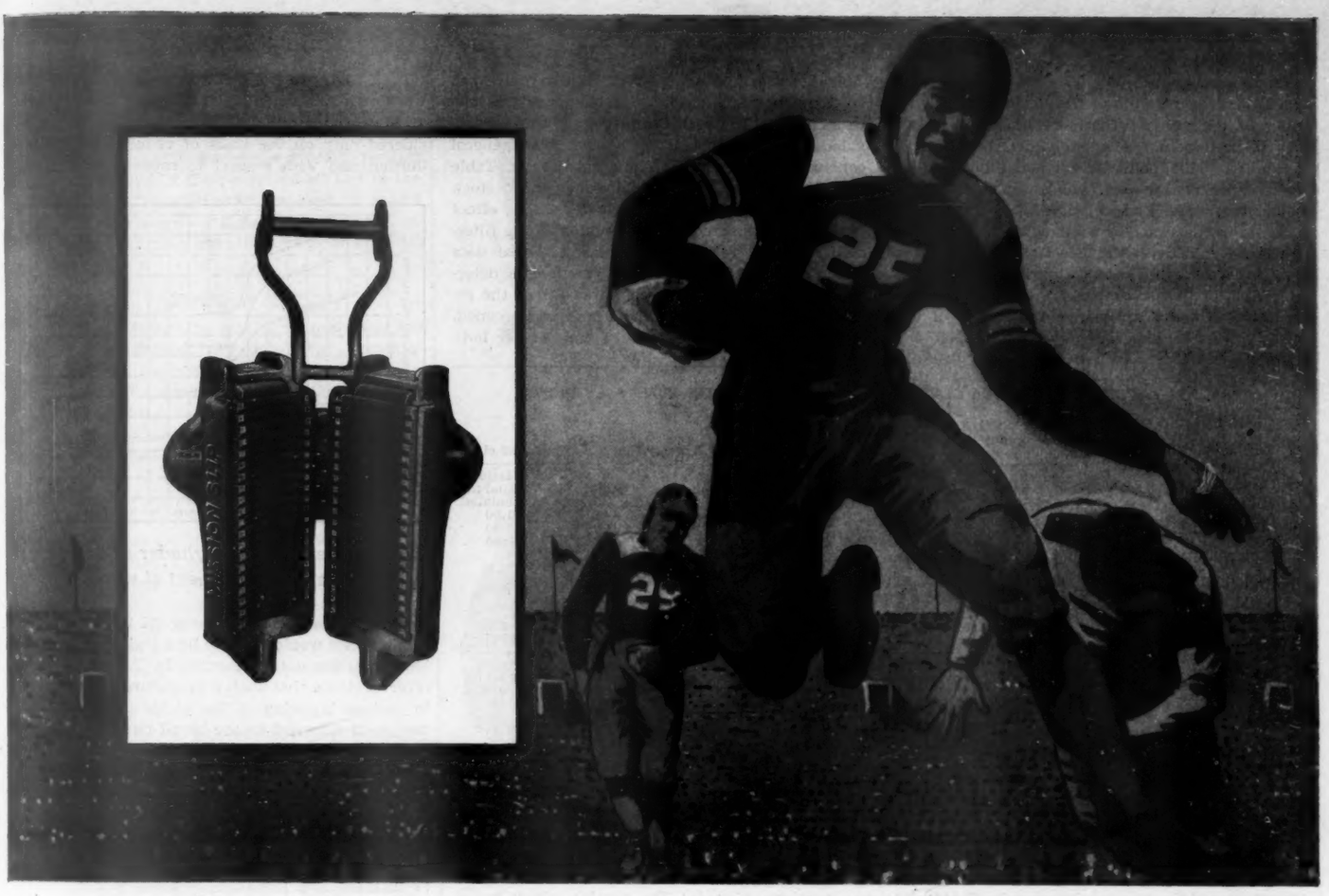

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fended, because the color of the solution depends upon the concentration of the stock as well as the color of the oil. Furthermore, the color of the net stock does not adequately determine its filterability. This point is further illustrated by some experimental work which was conducted to determine: (1) The relationship between the color of recovered clay-wash cylinder stock and filterability; and (2) the effect of the addition of this clay-wash cylinder stock upon the filterability of blends of this stock and fresh cylinder stock. In Tables 6 and 7 are shown the results of two specific sets of experiments bearing upon this point:

TABLE 6—THE EFFECT OF EUREKA CLAY-WASH CYLINDER STOCK ON EUREKA CYLINDER-STOCK FILTER YIELDS

	Per cent stock in solution		Filter yields to 6 N.P.A. color (barrels per ton of clay)			
Solution	Eureka clay-wash stock	Eureka cylinder stock	Actual	Fraction of Eureka yield	Calculated yield, additive basis	Ratio, actual to Calculated
1	0	45.0	6.1	1.00	6.10	1.00
2	45.0	0	3.5	0.57	3.50	1.00
3	8.2	36.8	4.8	0.79	5.64	0.85
True color of stock	1,200	2,700				

TABLE 7—THE EFFECT OF EUREKA CLAY-WASH CYLINDER STOCK ON CABIN CREEK CYLINDER-STOCK FILTER YIELDS

	Per cent stock in solution		Filter yields to 6 N.P.A. color (barrels per ton of clay)			
Solution	Eureka clay-wash stock	Cabin Creek cylinder stock	Actual	Fraction of Cabin Creek yield	Calculated yield, additive basis	Ratio, actual to Calculated
1	0	45.0	46.0	1.000	46.0	1.00
2	45.0	0	3.5	0.076	3.5	1.00
3	8.2	36.8	17.5	0.380	38.1	0.46
4	4.1	40.9	26.5	0.580	42.0	0.63
True color of stock	1,200	444				

It should be noted that the clay-wash cylinder stock having a true color of 1,200 gave a filter yield of but 3.5 bbls. per ton; whereas the raw Eureka cylinder stock itself, having a true color of 2,700, gave a yield of 6.1 bbls. per ton. If the filterability of the two stocks were in direct proportion to the true colors, it would be expected that the clay-wash cylinder stock would be considerably superior to the raw cylinder stock. As is evident in Table 6, the filterability of the clay-wash cylinder stock was but approximately 57½ per cent of that of the raw cylinder stock. Furthermore, it is observed that the yields obtained from blends of these two different materials were appreciably lower than the calculated yield, indicating that the clay-wash cylinder stock had a yield-depressing effect upon the clay, regardless of its low initial color and its own filterability.

The effect of the addition of Eureka clay-wash stock upon the filterability of blends of this material and Cabin Creek cylinder stock was investigated, and is reported in Table 7. The general conclusion to be drawn from the data of Table 7 is the same as that for Eureka cylinder stock of Table 6, except that the yield-depressing effect of the clay-wash stock is accentuated as the filterability of the raw stock increases. These data indicate that the only practical method of determining the proper cut point, in so far as the return of filter wash to the blend tank is concerned, is the filterability of the stock; and further indicate that there is no apparent relationship between the color of the stock and its filterability.

From the above discussion it is evident that the filter wash should be divided into at least two portions, viz.: (1) The portion which has a filterability comparable to the raw charge stock; and (2) a subsequent portion which should not be returned to the filters, but which is generally processed for the recovery of the naphtha. In the event the oil recovered from the second portion is refiltered, it should be processed without admixture with stock of different filtration characteristics.

The Use of Recycle Wash

In some instances it has been the practice to use that portion of the wash which is not returned to the blend tank as a first part of the wash on a subsequent filter. In such cases this recycle wash is followed by clean naphtha. Considered only on the basis of reduced distillation burden and with respect to capacity of this recycle naphtha wash to remove oil from the clay, this practice would seem to be a logical procedure. However, the data presented in Tables 6 and 7 offer evidence that such a procedure might result in serious lowering of the yields obtained from the stock returned to the blend tank. This practice was investigated extensively in the plant. The results of a typical run are reported in Table 8. It is interesting to compare the filterability of the stock contained in the wash in these two

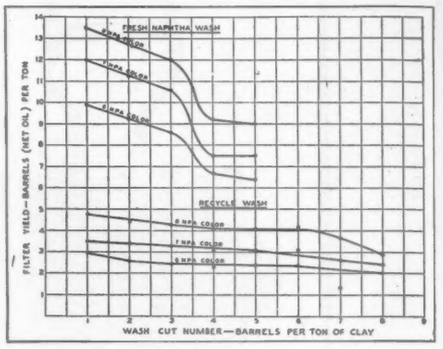

Fig. 6—Filterability of cylinder stock in clay wash per increment of wash

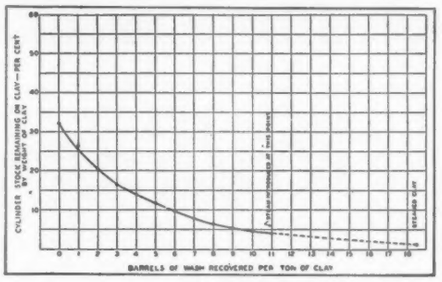

Fig. 7—Oil remaining on clay vs. number of barrels of wash

TABLE 8—WASHING DATA OBTAINED WHILE USING RECYCLE NAPHTHA

Sample No.	Total barrels per ton through at time of sample	Barrels per ton represented by sample	Solution tests: Color	Solution tests: Per cent stock	Stock tests: True color	Gravity °A.P.I.	Flash-point °F.	Fire-point °F.	Viscosity at 210° F. (seconds)	Pour-point °F.	Carbon residue (per cent)	Iodine No.	Yield of net oil percolated through No. 1 clay (Barrels per ton): Color 6 N.P.A.	Color 7 N.P.A.	Color 8 N.P.A.
1	0.96	0.964	4½+D†	34.70	778.75	26.6	535	595	145.0	75	2.025	..	2.98	3.50	4.80
2	1.93	0.964	4½+D	28.70	778.75	26.3	540	595	147.0	75	1.901	..	2.61	3.38	4.43
3	2.89	0.964	4 +D	24.20	937.50	27.0	525	590	143.0	75	2.078	..	2.48	3.30	4.30
4	3.85	0.964	4 +D	21.20	2,668.75	24.7	540	600	133.6	80	2.279	..	2.32	3.04	4.11
5	4.82	0.964	+8	15.40	1,112.50	27.3	530	595	142.0	75	2.078	..	2.42	3.08	4.04
6	5.78	0.964	+7	14.00	937.50	25.9	550	595	149.0	75	2.471	..	2.43	3.10	4.16
7*	6.75	0.964	6 +	10.00	.....	...	...	...	.....	..	2.598	..	1.36	2.55	3.65
8	7.71	0.964	+6	6.30	3,356.25	25.6	530	595	157.0	..	2.581	..	1.99	2.40	2.91
9	8.68	0.964	+5	3.90	2,186.52	24.7	495	585	159.0	75	3.154	..	...	...	...
10	9.64	0.964	4½+	3.00	2,186.52	24.0	505	590	162.0	80	3.231	..	...	...	...
11	10.60	0.964	+4½	2.50	1,310.00	25.0	520	580	159.0	65	3.574	..	...	...	...
12	11.57	0.964	+4½	2.00	355.00	24.5	540	590	180.0	75	3.160	..	...	...	...
13	12.53	0.964	+4½	1.10	3,356.25	20.0	460	515	223.6	70	5.960	..	...	...	...
14	13.50	0.964	4 +	0.67	8,850.00	18.8	...	...	374.0	..	8.810	45	...	...	...
15	14.46	0.964	3½+	0.42	12,937.50	14.4	...	...	935.0	..	12.030	81	...	...	...
16	15.42	0.964	3½+	0.34	12,937.50	14.7	...	...	833.0	..	12.090	53	...	...	...
17	16.39	0.964	+3½	0.30	12,937.50	14.1	...	...	864.0	..	12.600	51	...	...	...
18	17.35	0.964	+3½	0.32	9,637.50	15.3	...	...	529.0	..	11.490	50	...	...	...
19	18.32	0.964	+3½	0.31	12,937.50	14.7	...	...	657.2	..	9.090	53	...	...	...
20	19.38	0.964	+3½	0.30	8,850.00	14.4	...	...	651.0	..	10.890	55	...	...	...
21	20.24	0.964	3 +												
22	21.21	0.964	+4	0.30	12,000.00	14.2	...	...	872.0	..	8.010	58	...	...	...
23	22.17	0.964	+4½												

*Clean naphtha started in top of filter at this point. Cuts 8 to 14, inclusive, segregated for first wash on next filter. †Dilute.

Tests on Material Used for First Part of Wash

Solution tests: Color	Solution tests: Per cent stock	Stock tests: True color	Gravity, °A.P.I.	Viscosity at 210° F. (seconds)	Carbon residue (per cent)
5+	3.2	2,325	24.2	157	3.13

Tests on Naphtha Used for Washing

Color	30+
Gravity, °A.P.I.	58.3
A.S.T.M. distillation in °F.:	
Initial boiling point	198
5 per cent point	236
10 per cent point	245
20 per cent point	256
30 per cent point	266
50 per cent point	282
70 per cent point	301
90 per cent point	332
Endpoint	382
Recovery, per cent	97

instances (Tables 5 and 8, also Figure 6) in as much as these tests give a direct comparison between the use of clean naphtha throughout and the use of recycle wash. It is obvious that the recycle was practically as effective as fresh naphtha in so far as the removal of oil from the filter was concerned, but there was a great difference in the filterability of the recovered oil and in the filter yields. If recycle wash is used, it would appear that extreme care must be exercised to avoid the introduction into the charge of material of low filterability.

Summary

1. In plant filters the rate of draining and the total amount drained are dependent primarily upon the condition of the screen.
2. In naphtha washing a low uniform washing rate is desirable.
3. The first portion of the washing naphtha should be applied at a temperature below that of the filter, and in such volume as is necessary to remove the filterable oil. The subsequent washing naphtha should be added at a temperature above that of the filter for the purpose of dissolving an increased proportion of the tar.
4. A paraffinic naphtha of low vapor pressure and low endpoint should be used in washing.
5. An appreciable increase in the viscosity of the original charge increases the amount of naphtha necessary to reduce the oil content of the filter to a specific magnitude.
6. The color of the cylinder stock recovered in the clay wash is not indicative of its filterability.
7. The filterability of the oil contained in the washings is at present the only criterion that can be used in judging the fraction to be returned to the blend tank for reprocessing.
8. Clay-wash cylinder stock should not be blended with stocks of better filterability, in as much as this material decreases the filter yields to a much greater extent than its arithmetical proportion.
9. When recycle wash is used, extreme care must be taken to avoid introducing into the system material of poor filterability.

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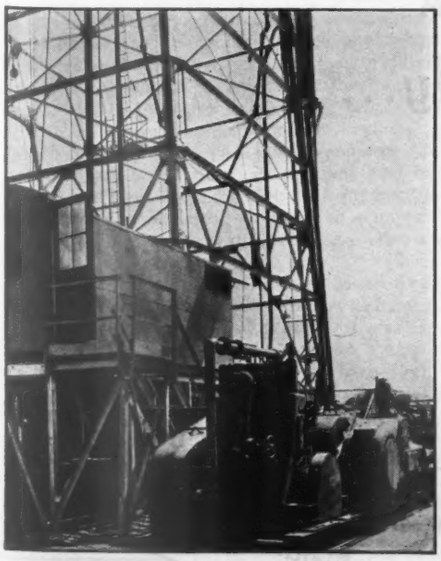

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Operating Costs of Multicylinder Gas Engines

By JAMES McNEILL
Union Oil Co. of California, Santa Fe Springs, Calif.

A.P.I. — Paper presented at annual meeting, Chicago, 1938

At the present time approximately 2,500 multicylinder gas engines are used for pumping oil wells in California. In 1932 there were less than 50. This rapid increase is due both to the low first cost and operating economy of multicylinder gas engines and to the development of individually-powered portable pulling equipment which permits the use of lower-powered engines for pumping service.

Multicylinder gas engines were first used in California during 1930. About this time small operators began to use old automobile engines on their wells. These engines proved to be surprisingly dependable and economical to operate, and in 1932 the industrial-engine manufacturers entered the field.

Engines of many types and sizes are now used. Sizes range from 100 to 800 cubic inches in displacement, with four, six, or eight cylinders. Loads as low as 5 hp. and as high as 75 hp. are being carried economically—using, of course, the proper size engine for the job. Four cylinder, 250- to 400-cubic-inch engines predominate, but the present trend is toward six-cylinder engines because of their wider speed range and higher horsepower output per cubic inch of displacement.

Operating Costs

Fig. 1 is a summary of the operating costs of multicylinder gas engines as experienced by a California company. This company operates more than 250 engines in pumping service, has a trained maintenance personnel, and keeps accurate cost records. All of the engines are of the four-cycle type, and four different makes are represented. The costs shown are based upon lubricating oil at 68 cents per gallon, repair and maintenance labor at $1.20 per hour, parts as billed, and fuel (dry gas) at 10 cents per 1,000 feet. The engines have been grouped according to size and number of cylinders, and the operating costs are shown as averages per engine per day.

Two totals are shown; one includes all operating costs except fuel; the other includes all operating costs as well as fuel. This was done because in some fields gas fuel is not a true expense, but merely a bookkeeping charge; while in others the cost may be some figure other than 10 cents per 1,000 feet.

The column entitled "range in which 68 per cent of the engines fall" is the dispersion or standard deviation of the cost data fitted to a normal distribution curve, and has been included in order to show the spread of the individual costs making up the average. It amplifies the average, and means that 7 out of 10 engines in the group fell within the indicated range. "Formal statistical analysis" was used to calculate the figures for this column. The calculations are omitted, because they are tedious and of little consequence in themselves.

Fig. 2 shows fuel consumption of an average engine, for various load factors, using 1,100 B.t.u. of gas. This is applicable to any multicylinder gas engine of types and sizes considered in this paper. Data for the curve were obtained by actual tests. The engines used in these tests had compression ratios of 6 to 1; were equipped with a full complement of accessories; and had their carburetors adjusted for 99 per cent of maximum power. The use of this curve facilitates calculation of fuel consumption when the size of the engine and the expected load are known.

Figs. 3 and 4 are plotted from the data in Fig. 1. Fig. 3 represents operating costs, exclusive of fuel; and Fig. 4 represents operating costs, including fuel, plotted against revolutions per minute times cubic inches displacement. It is the author's opinion that the operating cost of an engine depends primarily upon these two factors, and that the B.M.E.P. (brake mean effective pressure) has little or no influence if kept below 60 pounds per square inch. For this reason, expressing operating costs in terms of a horsepower day or hour has little significance. For example, an engine operating with 25 pounds B.M.E.P. will develop twice the horsepower with 50 pounds B.M.E.P. at the same speed of rotation, but the operating costs will remain virtually constant.

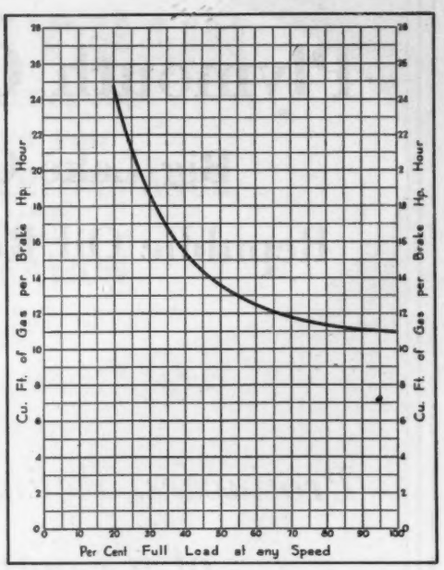

Fig. 2—Representative fuel consumption in relation to load factors for multicylinder gas engines fully equipped with accessories and using 1,100 B.t.u. gas

In analyzing these data, an attempt was made to correlate operating costs of engines with length of service, but no relationship could be established; and the information available does not indicate that operating costs increase as the engine grows old. The maximum length of service of the engines considered is six years. Engines properly applied and maintained can be made to run probably as long as repair parts are available. What the economical or useful life expectancy is has not been determined. It is generally held that 10 years is a reasonable figure. Some operators believe that it may be 20 years.

Operating Economies

Economical operation of multicylinder gas engines depends upon their proper application, and upon an intelligent, trained personnel to service

Engine Data							Average Cost per Engine per Day—Lubricating Oil, Repairs, Maintenance						
Group	Number Engines in Group	Average Cu. In Displacement of Group	Number of Cylinders	Average Speed in R.P.M.	Estimated H. P. Range of Group	Average Days Service per Engine	Lubricating Oil at .68¢ per Gallon	Maintenance and Repair Labor at $1.20 per Hour	Maintenance and Repair Parts as Billed	Total All Operating Costs Except Fuel	Range in Which 68% of Engines Fall	Daily Cost Fuel at 10¢ per M.C.F.	Daily Total All Operating Costs Including Fuel
A	2	113	4	1300	5	730	$.10	$.08	$.02	$.20	——	$.20	$.40
B	15	217	4	1100	5-15	208	.11	.14	.02	.27	$.14-$.40	.40	.67
C	23	280	4	800	5-15	995	.17	.15	.04	.36	.29-.43	.36	.72
D	120	350	4	900	7-25	615	.22	.16	.05	.43	.27-.59	.37	.80
E	13	425	4	800	10-35	748	.18	.14	.05	.37	.27-.47	.47	.84
F	32	290	6	1100	10-30	198	.15	.15	.02	.32	.22-.42	.43	.75
G	23	428	6	1100	15-40	350	.31	.29	.05	.65	.40-.90	.55	1.20

Fig. 1—Summary of operating costs—multicylinder gas engines

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them. The California Subcommittee on the Maintenance of Multicylinder Gas Engines recommends that engines be selected so that the B.M.E.P. will fall between 40 and 60 pounds per square inch, with piston speeds not exceeding 1,000 feet per minute. Occasionally, small-bore engines are run with piston speeds of 1,200 feet per minute.

In the final analysis, the relative economy of operating engines in pumping service depends upon the field service men. Needless tinkering or

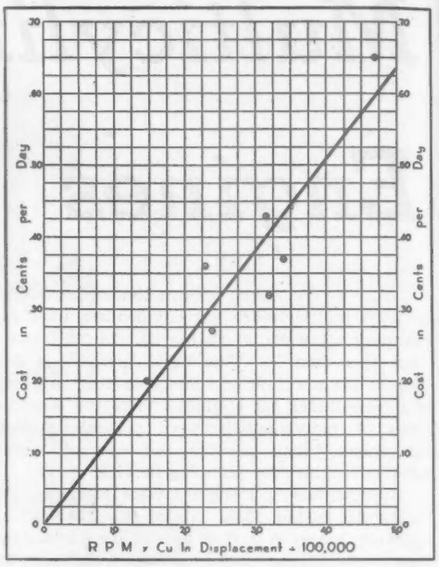


Fig. 3—Multicylinder gas engines operating cost, except fuel vs. displacement × r.p.m.

repairs, unnecessary replacement of parts, or willful neglect will result in excessive costs. The practice of most California companies is to service the engines once a month. Servicing includes changing oil, greasing, inspecting the ignition system, checking compression, and minor adjustments and repairs. All repairs, whenever possible, are made in the field. If the job will cause the well to be shut down for too long a period, the engine is replaced with a spare, and is taken to the shop.

The costs presented are low, but not lower than those of many other California companies. Any operator who carefully will engineer the selection of engines, and who will train his service and maintenance personnel, can duplicate them.

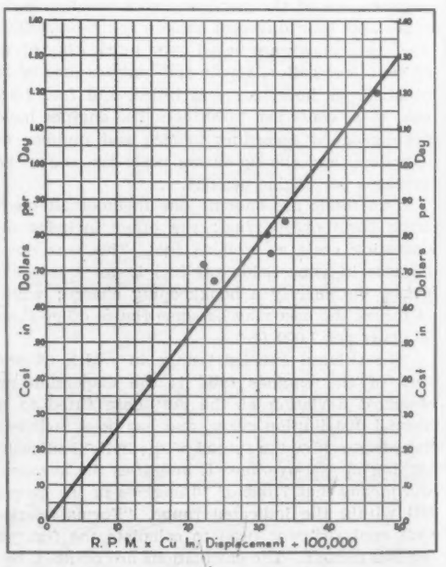
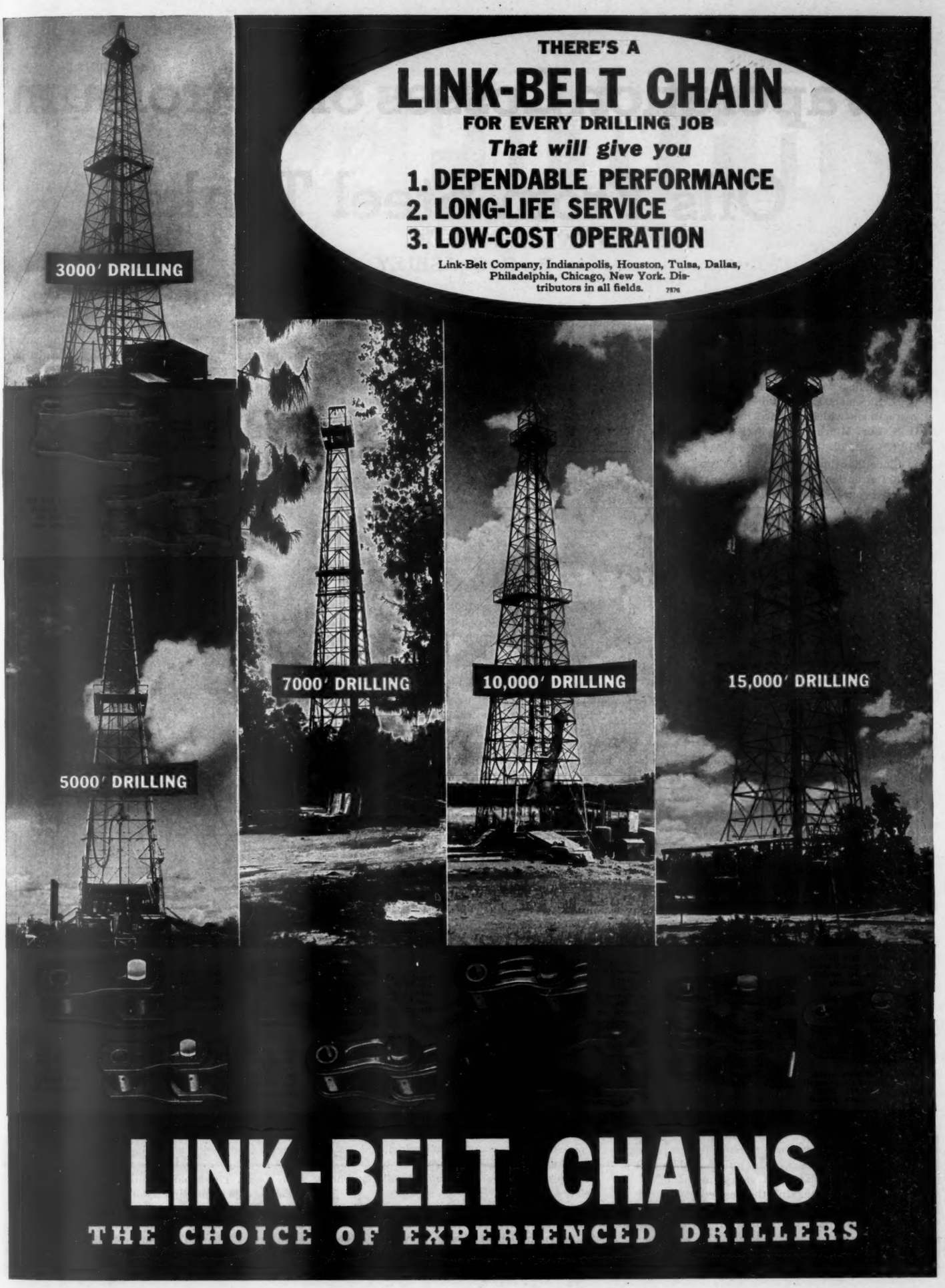


Fig. 4—Multicylinder gas engines operating cost, including fuel vs. displacement × r.p.m.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Evaporation Losses of Petroleum Oils From Steel Tanks

By C. C. ASHLEY
Shell Oil Co., San Francisco, Calif.

The economic significance of losses incurred from the evaporation of volatile fractions of petroleum oils during handling and storage began to receive the general attention of the oil industry early in the last decade, when the U. S. Bureau of Mines undertook a series of investigations which resulted in the publication of U. S. Bur. Mines Bull. 200 (February 1922) and 319 (August 1923)—both written by J. H. Wiggins.

Since that time the subject has received a great deal of attention, as evidenced by the development of vapor-conservation devices such as tank breather valves, vapor interconnecting and recovery systems, floating and breather roofs, tank-roof insulation and cooling methods, etc.; yet there does not seem to have been developed any general plan of attack, either in the study of the magnitude of evaporation losses, or in the presentation of the data secured. Few data have been available from which could be made a reasonably accurate prediction of the evaporation losses that might be expected under any given storage or filling conditions, and upon which to base decisions regarding the most desirable type of roof construction or tank-venting facilities. Predictions have been avoided as far as possible, with the excuse that "there are too many variables involved."

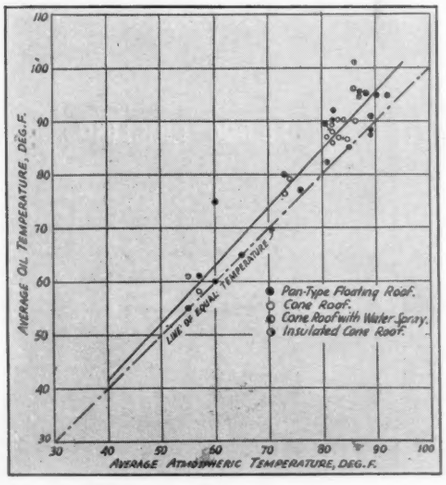

Fig. 1—Relation of atmospheric temperature to temperature of standing oil in steel storage tanks

This investigation was undertaken in an effort so to correlate and compare all available tank-evaporation loss data that charts might be prepared to assist in making the desired predictions. Data have been secured from the files of the Shell Oil Co. and affiliated companies, from correspondence with and material published by equipment manufacturers, and from government and technical publications. More than 30 separate articles and reports, covering more than 200 individual tests, have been reviewed, and the essential data tabulated; and from these data have been selected the 62 items used in the preparation of the charts.

The original data were secured by various test methods, including quantitative determination of the amounts of vapor lost and of the change of oil volume in the tanks, and qualitative determination of the change in physical properties of the oil as a result of the loss. A discussion of various test methods follows:

***A.P.I.*— Paper presented at annual meeting, Chicago, 1938**

Evaporation-Loss Test Methods

Quantitative test methods are:

1. Measurement of vapors lost.
2. Measurement of change of oil volume.

1. Measurement of vapors lost involves volumetric determination of the vapor quantity discharged from a tank while breathing out, and analysis of the vapors to determine their hydrocarbon content, from which the volumetric loss of hydrocarbon can be computed. Orifice-meter measurements of vapor volumes are the simplest and most accurate, while vapor richness may be determined by absorption with activated charcoal or by an absorption train, or by the "freezing method" which liquefies the hydrocarbons in the exhaled vapor. The latter method is the most accurate, and appears to give results sufficiently reliable to use in studies of this kind.

The serious defect in tests made by vapor-volume measurements lies in the fact that it is usually quite difficult to insure that there are no roof leaks, i.e., that all vapor is discharged at the point of measurement; for vapor losses not recorded nullify the accuracy of the method.

2. Measurements of changes of oil volume are made by customary gauging methods, and are subject to all the inaccuracies thereof. Large tanks cannot be gauged closely enough to detect small losses, while in every case losses due to tank leakage cannot be separated from those due to evaporation. The effect of tank-bottom leakage can be minimized by carrying a water gauge, but shell leakage cannot be prevented nor, with volatile oils, detected.

Gauging methods should not be used except as a check on other more accurate methods, because of the uncertainty of the magnitude of leakage losses which are unavoidably included.

Qualitative test methods are:

1. Determination of change of distillation characteristics.

2. Determination of change in composition of oil with respect to the most volatile fractions.

3. Determination of change of vapor pressure of the oil.

1. Early investigators found that changes of the physical properties of an oil due to the loss of volatile fractions could be used as an indication of the amount of loss, and used fractional distillations according to the U. S. Bureau of Mines method. The change of slope of the U. S. Bureau of Mines distillation curve at the 10-per-cent point was used as the basis of loss determination. This method is no longer used, as it was found lacking in the inherent accuracy required in this work.

2. The change in the composition of an oil with respect to its most volatile fractions, as determined by Podbielniak analysis, has been used to some extent. The accuracy of this method is open to question, in as much as it is assumed as part of the procedure that there are no losses of the heavier fractions of the oil by evaporation—which may not be strictly true.

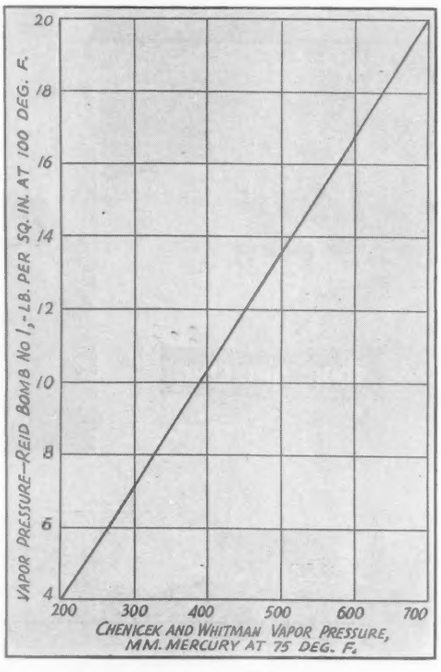

Fig. 2—Comparison of vapor-pressure determinations by Reid and Chenicek and Whitman methods

3. Methods involving the change of vapor pressure of an oil with a loss by evaporation appear to be the most desirable for the determination of such losses. The rapidity with which evaporation occurs is dependent directly on the vapor pressure; consequently, that property is the most logical to use in loss studies, while the test methods that have been developed appear to possess the necessary accuracy.

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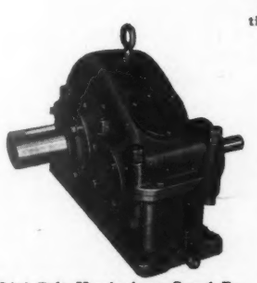

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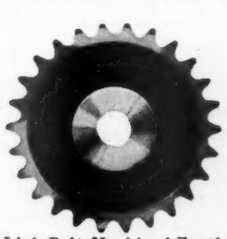

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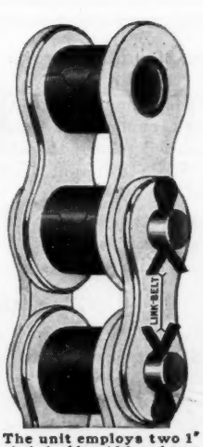

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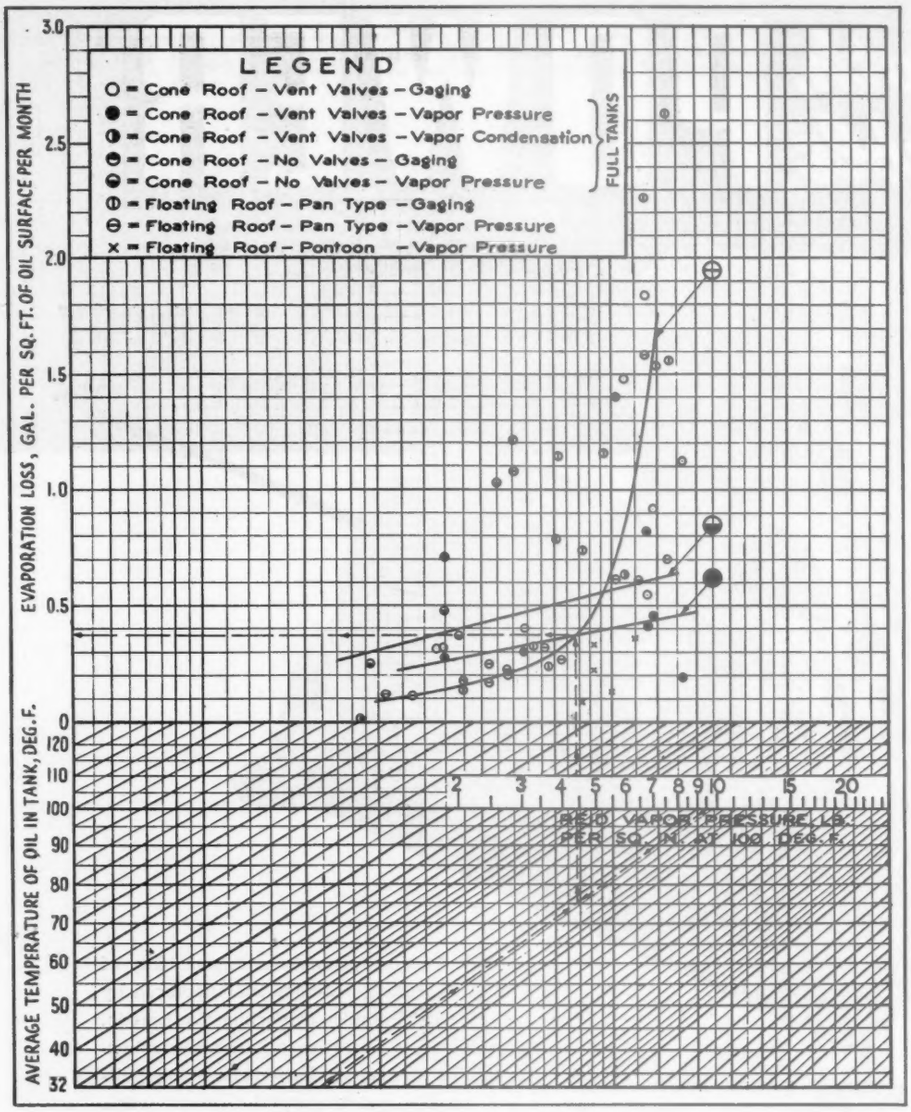
LEGEND
O = Cone Roof – Vent Valves – Gaging
● = Cone Roof – Vent Valves – Vapor Pressure
◑ = Cone Roof – Vent Valves – Vapor Condensation
⊖ = Cone Roof – No Valves – Gaging
⊖ = Cone Roof – No Valves – Vapor Pressure
⊕ = Floating Roof – Pan Type – Gaging
⊖ = Floating Roof – Pan Type – Vapor Pressure
x = Floating Roof – Pontoon – Vapor Pressure
FULL TANKS
EVAPORATION LOSS, GAL. PER SQ. FT. OF OIL SURFACE PER MONTH
AVERAGE TEMPERATURE OF OIL IN TANK, DEG. F.
REID VAPOR PRESSURE, LB. PER SQ. IN. AT 100 DEG. F.

Fig. 3—Evaporation loss of petroleum oils from standing storage in steel tanks

test method involving changes of the physical properties of oils because of evaporation loss, viz., that the fractions evaporated in laboratory test apparatus are the same as those lost from the oil in the tanks under field conditions. The probable error from this source is believed to be negligible.

Early applications of vapor-pressure method were made by weathering weighed laboratory samples of the oils in question to establish the change of vapor pressure with loss in weight. To reduce field observations to a volumetric basis required that the specific gravity of the fractions lost be assumed, which reduced the accuracy and value of the method.

At the 1930 meeting of the American Petroleum Institute Messrs. Chenicek and Whitman, of the Standard Oil Co. (Indiana), presented a paper outlining a procedure and apparatus for a vapor-pressure method of determining evaporation losses. Their apparatus gave vapor-pressure readings corresponding directly to percentage volumetric loss of oil—which eliminated the assumptions required with earlier methods to convert weighed to volumetric losses.

This method is felt to be the best now available. Its only weakness lies in the method of sampling, the standard procedure being to take samples from the mid-depth of the oil in the tank—which may not be truly representative of the tank contents in cases where evaporation losses are high and the surface layer of the oil may contain different fractions from the main body of the oil.

Additional field study to establish a sampling procedure that would insure the taking of representative samples seems desirable.

Discussion

It became evident early in this investigation that, if charts were to be prepared successfully, it would be necessary to eliminate, or combine to secure the same effect, many of the variables affecting evaporation losses. The following variables must be included for consideration:

Vapor pressure of the oil.
Oil surface temperature.
Average oil temperature.
Weather, which includes sun, wind, rain, cloud, fog, etc.
Tank size.
Kind of tank roof, including vents.
Pressure setting of vent valves, when used.
Tank paint.
Degree of filling.

In the past many test results have been compared on bases such as "gasoline—summer exposure," or "vapor pressure (Reid) in pounds per square inch at 100° F.," without regard to the temperature of the oil under test. It, therefore, appears possible that comparisons were being drawn between tests that were not really comparable; and this led to the selection, as a basis for this study, of a factor which is believed to be the most comprehensive of any so far used in this work.

This factor is "vapor pressure of oil at average temperature of oil in tank." Vapor pressure was chosen because it is the basic cause of evaporation; while correction to the oil temperature practically eliminates from consideration all variables of weather, tank size, and painting. By presenting a separate curve for each, variables of roof and vent construction, vent-valve pressure setting, and degree of filling (for cone-roof tanks) can be handled easily.

It is recognized that the volumetric magnitude of breathing losses from standing storage depends on the variation of temperature in the tank vapor space, which is in turn dependent principally on the amount and intensity of direct solar radiation falling on the tank. At the same time, however, the heat input to the body of oil in the tank—which enters largely through the tank shell—is also dependent principally on solar radiation. It is, therefore, believed that variations in conditions affecting the volume of breathing losses will be reflected in temperature changes in the body of oil in the tank and that, as a consequence, the factor selected represents a logical basis of comparison for tests of sufficient duration that brief extreme local variations will not overshadow normal average conditions. It is true that hypothetical conditions could be assumed where the factor selected would not hold, but it is felt to be adequate for actual field conditions.

Evidence that the factor chosen includes variables of weather, tank size, and painting is illustrated in Figure 1, "Relation of Atmospheric Temperature to Temperature of Standing Oil in Steel Storage Tanks," wherein the plotted points include tanks from 15 to 97 per cent full; from 1,500- to 85,000-bbl. capacity, with the roof constructions noted thereon—in tests of from 5 to 62 days' duration. With all these differences, the one curve that is plotted as the mean of all points will serve almost equally well for any group. This indicates that the major heat input to the oil in a tank is through the shell, and that roof construction or vapor-space volume has little effect on the way in which weather conditions affect the temperature of the oil. Thus, the oil temperature is seen to be affected by the same variables as the tank breathing—which confirms the logic of the selection of the factor chosen for comparisons.

For plotting the desired curves of evaporation losses, it was necessary that the test data should include data on vapor pressure and average oil temperature during the test. In some cases it was found that average atmospheric temperatures were available instead of oil temperatures—in which case values for the oil were estimated from Figure 1. In other cases only the location and time of the test were given, and average atmospheric temperatures were estimated from known data under approximately similar conditions, and the oil temperatures estimated therefrom.

It was desired to plot the curves against a standard method of vapor-pressure measurement—Reid at 100° F. being chosen. This required a correlation between the Chenicek and Whitman and the Reid values—which was determined to be, as shown in Figure 2, by correlation with secondary data available in Shell Oil Co. files.

Results

For the presentation of this study it was desired to plot the following curves:

1. Evaporation loss from standing storage for:

(*a*) Full cone-roof tanks without vent valves.
(*b*) Full cone-roof tanks with vent valves.
(*c*) Full cone-roof tanks with vent valves, and insulated or water-cooled roofs.
(*d*) Tanks with pan-type floating roofs.
(*e*) Tanks with pontoon-type floating roofs.
(*f*) Full tanks with breather roofs.

2. Variation of evaporation loss from cone-roof tanks with degree of filling.

3. Variation of evaporation loss from cone-roof tanks with increase of vent-valve operating pressure.

4. Evaporation loss from cone-roof tanks due to pumping in.

Available data were inadequate to plot curves for items (1-*c*), (2), and (3) above; while a curve for (1-*f*) was omitted, as the data showed that breathing losses from breather roof tanks standing full was negligible.

The remaining data under item (1) are presented in Figure 3, "Evaporation Loss of Petroleum Oils from Standing Storage in Steel Tanks" —losses being given in terms of "gallons per square foot of oil surface per month," which factor was selected as being most desirable from the standpoint of correlating test results from tanks of different sizes. This chart is entered with a reading of vapor pressure on the Reid scale, moving along the inclined guide lines (which are based on the Cox curves of vapor pressures) to an intersection with the proper horizontal temperature line, which corrects the vapor pressure to the temperature of the oil in the tank, and thence vertically to an intersection with the curve for the specific case in hand, reading the answer along the left margin of the chart. The dashed lines on the chart are an example.

On this chart, curves are given for full cone-roof tanks with and without vent valves, and for pan-type floating-roof tanks. Points have been plotted for pontoon-type floating-roof tanks; but no curve was drawn, as the points were too few.

It is significant to note the rapid rise of the curve for pan-type floating roofs with increase in vapor pressure. This checks the observations of several investigators that high losses were sustained with volatile oils stored under such roofs when exposed to direct sunlight, due to boiling of the oil in contact with the roof. The advantage of the pontoon type of floating roof in this respect is illustrated by the position of the points for the pontoon-type roofs in relation to the curve for the pan-type roofs.

The data under item (4) are shown in Figure 4, "Evaporation Loss of Petroleum Oils from Pumping Into Steel Tanks." Results are presented in terms of "per cent loss of innage volume." Test results on which to base this curve are rather meager, and also somewhat inconsistent. They give reasonable justification for the lower end of the curve shown, while the rest of it was drawn at such a slope that the loss with increasing vapor pressure would vary in the same ratio as the loss from standing storage in cone-roof tanks with vent valves. The method of using this chart is the same as that given for Figure 3.

In studying and criticizing these charts, it should be kept in mind that the data upon which they are based are derived from a large number of sources, among which there has been little or no coordination of test procedures or methods. Results have been taken at face value, without knowledge or means of determining their inherent accuracy—except that for the actual location of curves tests by gauging have been discounted in favor of tests by vapor-pressure methods, with decided preference being given to those conducted by the Chenicek and Whitman method. The curves are believed to represent reasonable values based upon the present volume of adequate data. They

(Continued on Page 177)

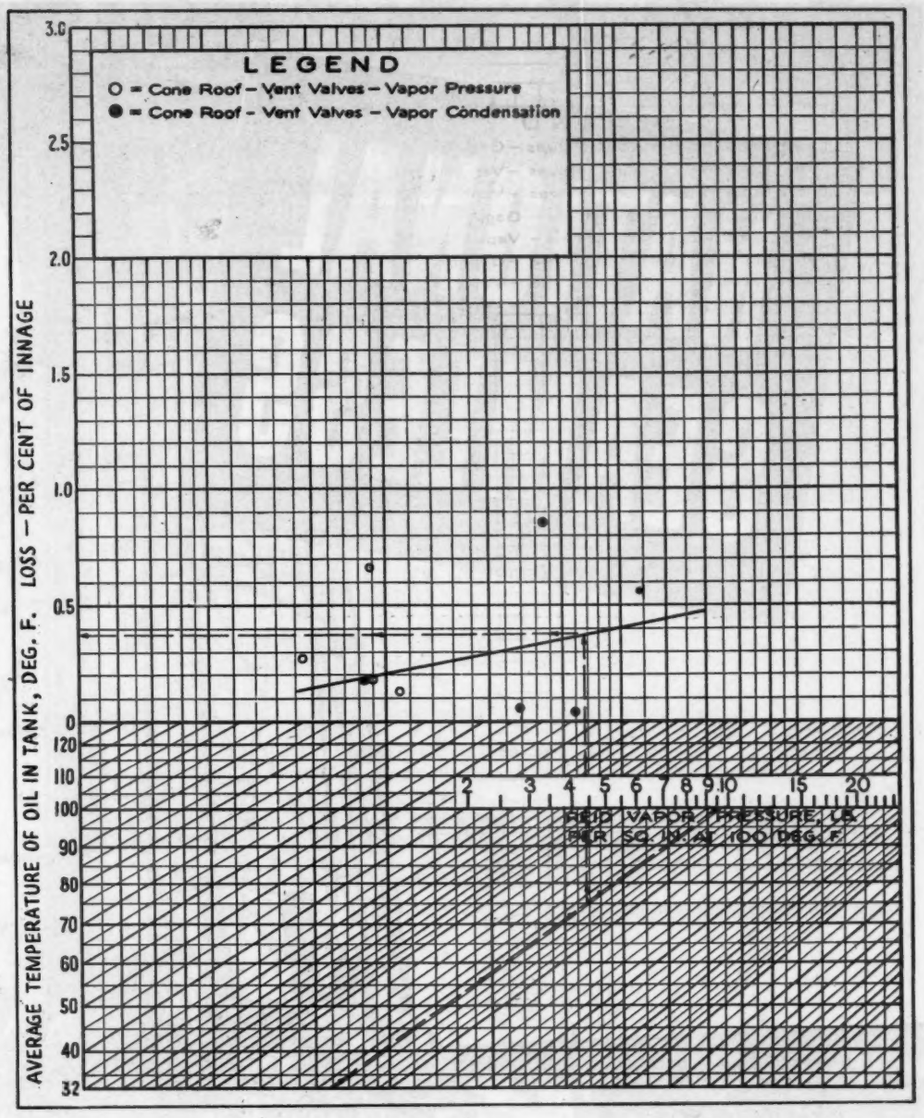

Fig. 4—Evaporation loss of petroleum oils from pumping into steel tanks

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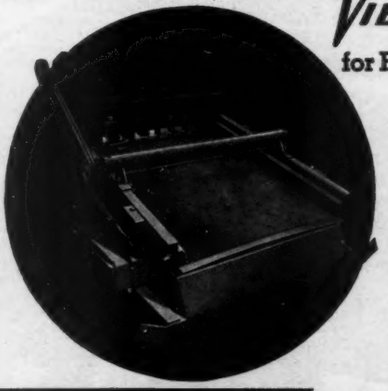

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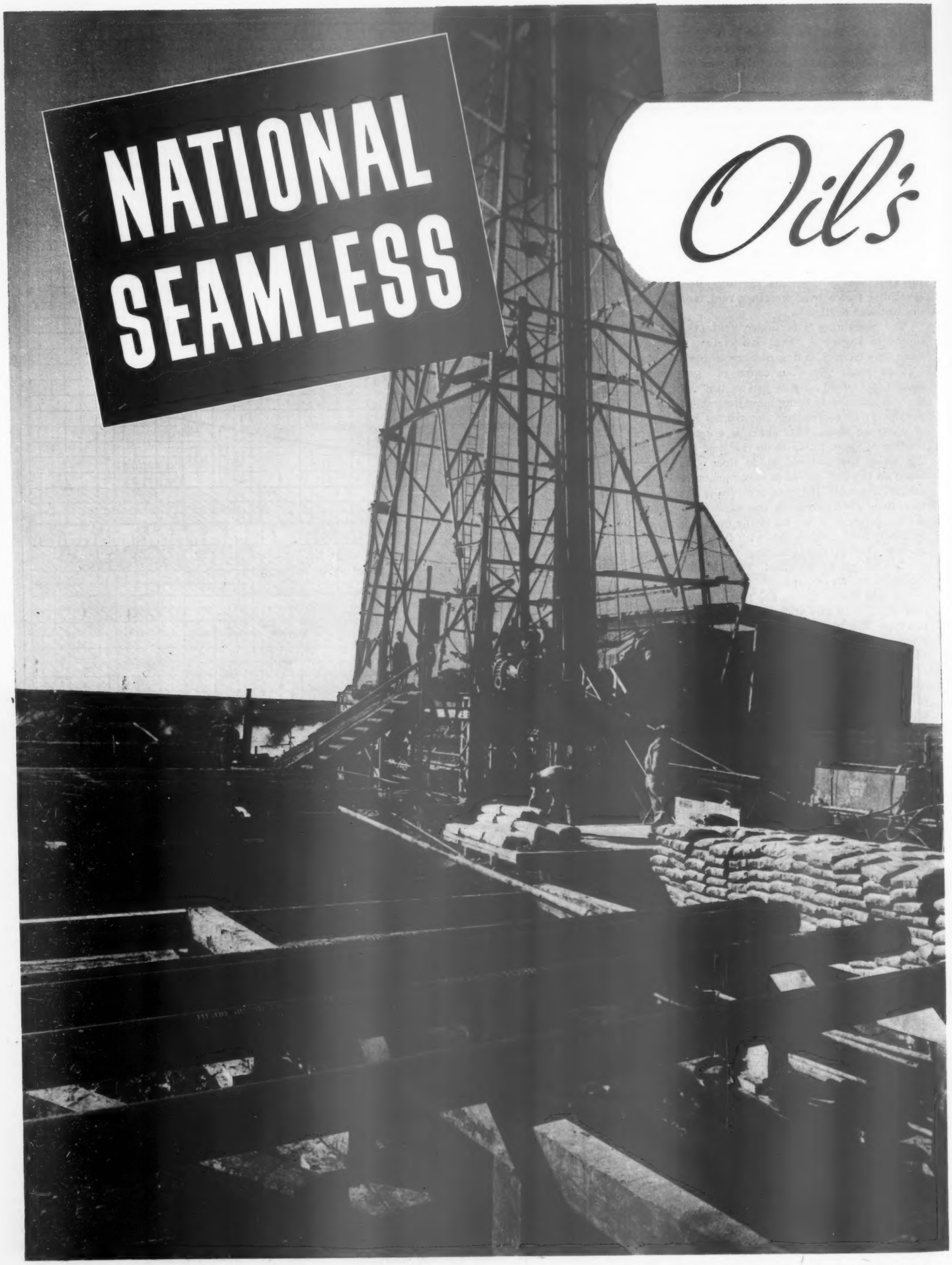
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are, of course, subject to revision as additional data may become available.

It is desired to call attention also to the fact that the data on which this report is based are all derived from oils of relatively low Reid vapor pressures, and that it is probable that the curves presented would not apply to oils of high vapor pressures. With oils of the latter type, tank temperature increases due to solar radiation might reach the boiling point of the product, so that further heat input would be absorbed as latent heat of evaporation—resulting in high losses, without an observed increase in the oil temperature. In this case the linear relation between average atmospheric and oil temperatures indicated in Figure 1 would no longer hold. Test data on which to establish satisfactory relationships for high-vapor pressure oils are not available.

As noted above, none of the data available during this study presented information on the effect of increased vent-valve pressure setting—all results herein being applicable to valve operating pressures of the order of 1 inch to 1½ inches of water, conforming to common practice in this country. In foreign practice, tank pressures as high as 20 cm. (8 inches) of water are being employed—from which appreciable reductions in evaporation losses are reported. . . .

The current expansion of low-pressure storage in containers of special shapes designed as pressure vessels may be considered an indication that the economics of pressure storage are fundamentally sound. . . .

Appendix

Accuracy of indivivdual tests requires that test data be taken at such times and by such means that test conditions shall be as nearly uniform as possible. . . .

The ability to correlate test data secured from different sources is dependent on the use of the same methods and procedure by all investigators. These requirements follow:

1. Take all oil samples, and make all gaugings between the hours of 2:30 and 5:30 a.m., which is the period when greatest uniformity of atmospheric and tank conditions exists.

2. Conduct all evaporation-loss tests by the vapor-pressure method, using the apparatus and procedure of Chenicek and Whitman.

3. Take all samples in accordance with the procedure recommended by Chenicek and Whitman, until a better method is developed and proved—when it should be adopted.

4. Every test should include the following data in addition to the Chenicek and Whitman vapor-pressure analysis:

(*a*) Daily record of average tank temperature, established by at least three readings spaced throughout the depth of oil in the tank. Whenever possible, readings should be taken at more than one point in the tank.

(*b*) Daily record of average atmospheric temperature and extreme temperature range.

(*c*) Vapor-pressure valves in the Reid scale to provide better correlation between that scale and the Chenicek and Whitman method.

(*d*) Initial and final tank gaugings as a check on the results by the vapor-pressure methods, and to indicate the magnitude of leakage losses.

(*e*) Dates of start and finish of test, and regional location thereof.

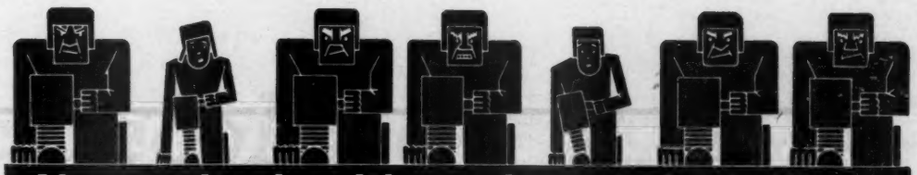
(*f*) Tank dimensions (including slope of cone roofs), kind of roof and roof appurtenances, and painting.

(*g*) Vent-valve operating pressures.

(*h*) Degree of filling of tank.

(*i*) For tests on losses by pumping in, the rate of filling.

5. Present all test results for comparison on the basis presented in this report, "vapor pressure of oil at average temperature of oil in tank," until additional data may show this criterion to be inadequate, and a better factor is developed.



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Hydraulic Decoking of Coke Chambers

By W. F. COURT
Shell Petroleum Corp., St. Louis, Mo.

A new and improved method of disrupting and removing coke from coke chambers on cracking and coking units has been developed by the Shell Petroleum Corp., and is now in commercial use.

The method consists of cutting the coke by means of high impact-producing water jets.

The following description pertains to an installation and operation of hydraulic decoking equipment now in commercial operation on a large continuous Dubbs combination cracking and coking unit, known as "Dubbs 17," at the Wood River refinery of the Shell Petroleum Corp.

This unit was designed by engineers of Universal Oil Products Co. in collaboration with engineers of the Shell Petroleum Corp. A general view of the unit is shown in Figure 1. The unit combines three processing operations, and receives as feed 16,500 bbls. of raw material daily—comprising 8,500 bbls. of topped crude, 2,000 bbls. of gas oil, and 6,000 bbls. of pressure distillate. It produces 7,000 bbls. per day of 70-octane gasoline (exclusive of the gasoline topped off the pressure-distillate portion of the charge) and approximately 300 tons of coke per day.

The primary cracking section consists of two full-flashing two-coil selective cracking units.

The coking section includes an Equiflux heater of special design for heating heavy cracked residuum, four coke chambers each 13 feet in diameter by 50 feet high, and a fractionating column with necessary condensers, etc.

Recracking Operation

One of the striking features of the operation of this unit is the re-cracking of cracked residuum to gasoline and coke. Cracked residuum of approximately 4° A.P.I. gravity is withdrawn from the flash chamber of the primary cracking section, and transferred to the bottom of the fractionating column on the coking section—where it mixes with the heavy re-cycle stock from the coke chambers. This material is then withdrawn by a hot-oil pump and charged to the Equiflux heater on the coking section, entering at a temperature of 760° to 780° F. It is further heated therein to a temperature of 925° to 950° F. before entering the coke chambers. These chambers operate at a pressure of 125 to 135 pounds per square inch.

At present the four coke chambers on this unit are used in a 48-hour cycle, only one at a time being on stream. The others are cut in when needed by means of switch valves, and in this manner the coking operation is carried on continuously. Each chamber is filled within 10 feet of the top, equivalent to approximately 150 tons of coke. Two chambers are cleaned every day. The average length of runs on the coking section of this unit is 30 days, the longest run to date having been 45 days. A photograph of the coking chambers on this unit is shown in Figure 2.

The conventional cable method formerly was used to remove the coke from the coke chambers on this installation. This method consisted of suspending layers of steel cable laid in spiral form throughout the chamber. At the end of the operating cycle, which in this case was about nine hours, the chamber was valved off, and the pressure released. It was then steamed, and cooled with water—after which the cable was pulled by means of a hoist, thereby disrupting and removing the coke from the chamber.

The cable method has now been displaced by the hydraulic method of decoking, which was developed and worked out on 10-foot by 40-foot coke chambers.

A.P.I. **— Paper presented at annual meeting, Chicago, 1938**

Operation

In the hydraulic decoking method, the hydraulic cutting nozzles are attached to special tools mounted at the end of a hollow stem, to which water is supplied from a high-pressure header through a steel-piping linkage made flexible by ball-bearing swivel joints. This stem is suspended from an overhead structure mounted above the chamber, and is lowered and raised within the chamber by means of an air hoist.

The operation of removing the coke comprises essentially two steps, viz.:

1. Boring a hole downward through the coke bed.
2. Cutting and removing the coke from the chamber.

In the first step a hole approximately 18 inches in diameter is bored downward through the coke bed by means of a revolving cutting head or boring tool which derives its power from the reaction of water jets discharging horizontally.

Utilize Two Steps

The boring operation is made in two steps to save excessive height in the overhead structure, and is interrupted at a point halfway down through the coke bed, in order that the stem may be lengthened sufficiently to carry the operation completely through the bed. The water discharging from the nozzles of the boring tool drains readily through the coke bed, and out of the bottom manway. A photograph of this boring tool is shown in Figure 3.

In the second step, the boring tool referred to above is removed from the stem at the bottom of the chamber, and replaced with a part of the assembly of cutting nozzles. The complete cutting assembly of nozzles used in this operation is divided into two sections, a "top section" and a "bottom section." The "top section," which has two nozzles, is elevated into the chamber first in order to make an enlarged opening in the coke bed at the bottom of the chamber so that the "bottom section" of the assembly can enter. After an enlarged opening has been cut at the bottom of the coke bed, the stem is lowered and the "bottom section" of the assembly is attached to the "top section," and the complete cutting assembly is then raised into the chamber.

The nozzles in the "top section" direct their jets horizontally, and the streams of water penetrate the coke bed to the chamber wall. The nozzles are offset so that the reaction from the streams of water rotates the nozzle assembly, thereby cutting

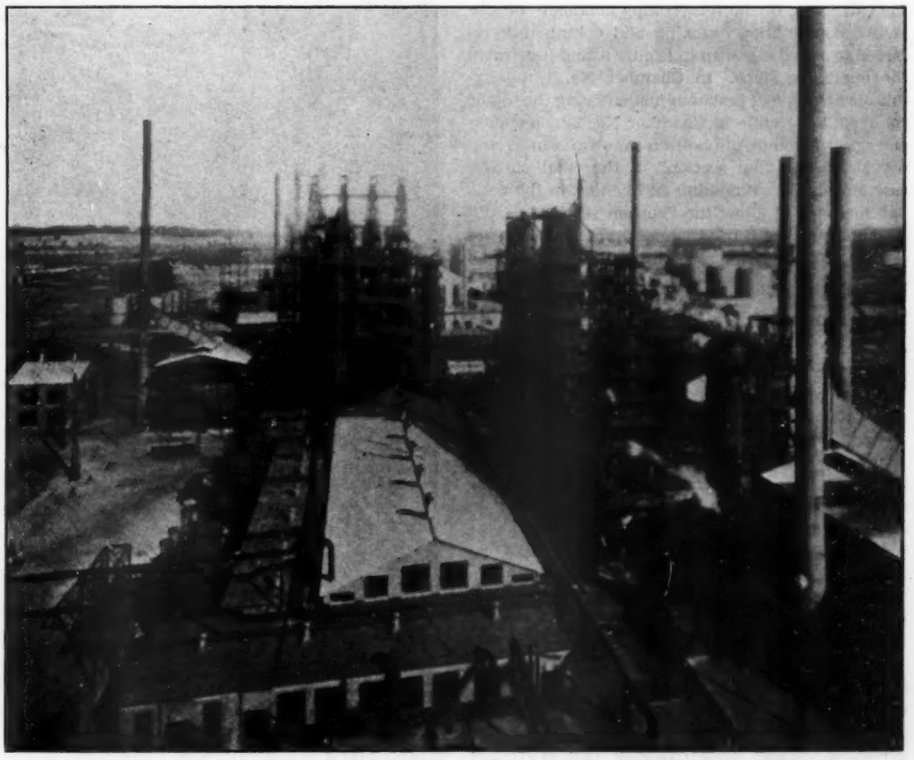

Fig. 1—General view of Dubbs unit No. 17, Shell's Wood River refinery

the coke bed into layers as the assembly is raised in successive steps by the operator. The "bottom section" has two nozzles pointing slightly upwards at an angle, and serves to cut the coke away from the wall. As the coke is cut into layers by the revolving jets, it breaks away and falls to the bottom of the chamber.

The cutting operation is likewise interrupted at a point half-way up through the coke bed in order that the stem may be shortened sufficiently to carry the operation completely through the bed to the top of the chamber.

A photograph of the final cutting assembly is shown in Figure 4. A photograph of the motor-driven high-pressure pumps used for jetting is shown in Figure 5.

During the cutting operation the coke and water fall through the bottom manway of the chamber directly into side-dump railroad cars. The movement of these cars is accomplished by means of an electric "car puller" controlled from a push-button station at the operating platform under the chambers.

The water draining from the coke cars falls onto a concrete floor and the fine coke it contains is washed into trenches. The trenches are provided with flushing jets so as to wash the fines into a collecting pit. The coke fines accumulating in this pit are continuously withdrawn as a "slurry" by means of a special centrifugal pump, and re-circulated back into a partly filled or into a full coke car—where the coke bed in the car acts as a filter to collect the fines.

Water from the coke-fines collecting pit passes through a screen into another compartment of the pit, and is pumped to a settling tank—where a further settlement of coke fines is effected. Coke fines accumulating in this settling tank are likewise recirculated as a slurry to the railroad cars. The clear water from the settling tank flows into a surge tank, from which it is again pumped by the high-pressure jet pump to the cutting nozzles in the chamber. The rate of flow to the cutting nozzles is approximately 700 gallons per minute under a pressure of 900 to 1,000 pounds at the entrance of the nozzles.

A drawing of the four coking chambers on the Dubbs combination cracking and coking unit referred to above is shown in Figure 6, and illustrates the operating steps. In Chamber No. 1 the hydraulic boring tool is shown just entering the top of the coke bed, while in Chamber No. 2 it is shown emerging through the bottom manway. In Chamber No. 3 the "top section" of the final cutting assembly is shown making an opening in the coke bed in order to allow the "bottom section" of the assembly to enter. In Chamber No. 4 is shown the complete final cutting assembly as it cuts away the coke.

Development of Hydraulic Decoking Method

From the foregoing description it will be concluded that decoking a chamber by this method is a relatively simple operation, requiring a minimum of mechanical equipment. The simplicity of design and operating technique, however, represents the result of a very large amount of development and experimental work. The nozzles, for example, presented quite a problem of design, in as much as such nozzles must produce a jet of water having a minimum of "stream spread" at a distance of 6 feet to 8 feet from the nozzle tip in order to obtain the necessary impact for maximum coke-cutting effect and speed.

Many nozzles of different designs were constructed and tested only to be discarded before a satisfactory design was developed. While considerable technical data are available on nozzle designs for other services and for relatively low pressures, design data covering this particular problem were not available. It was necessary, therefore, to follow the "cut-and-try" method in order to develop a satisfactory design.

Many nozzles of different sizes also were tried at varying pumping rates and pressures—with the result that, after a lengthy period of development work and experimentation, the correct sizes and shapes for the most economical pumping rates and pressures were determined.

Design of Nozzles

In collaboration with the Worthington Pump & Machinery Corp., the nozzles now used were perfected to a point where satisfactory impact is obtained at a distance of 8 feet from the nozzle tip, and at this distance the diameter of the effective stream is only 1¾ inches.

Many different designs of cutting tools, nozzle assemblies, and sequences of operating steps were tried—with the result that the present equipment and practice have reached a stage where it is possible to remove completely 150 tons of coke from a chamber and have it ready for heading up again in less than two hours' time.

The hydraulic method of decoking is applicable to the removal of coke of any degree of hardness.

Sometimes coke is so hard as to present difficulties in removal by the cable method. Such coke, however, readily is removed by the hydraulic method.

The percentage of lump- and egg-size coke produced by the hydraulic method is comparable with that produced by the cable method.

Experience has shown that degradation, i.e., breakage of coke, results mostly from its falling into the chamber and from subsequent handling, and bears little relation to the method of removal used.

The hydraulic method has opened new possibilities for reducing greatly the degradation. It also has opened up a new method of transporting coke.

Pump Coke

There are also very definite indications that the use of railroad cars for receiving and transporting coke to the storage yard or screening plant now can be done away with entirely. It has been demonstrated by tests conducted by the Allen-Sherman-Hoff Co. that coke and water in the correct ratio can be pumped by means of a special centrifugal pump to the coke pile, into hoppers, or directly to the screening plant. Surprising as it may seem, little degradation results

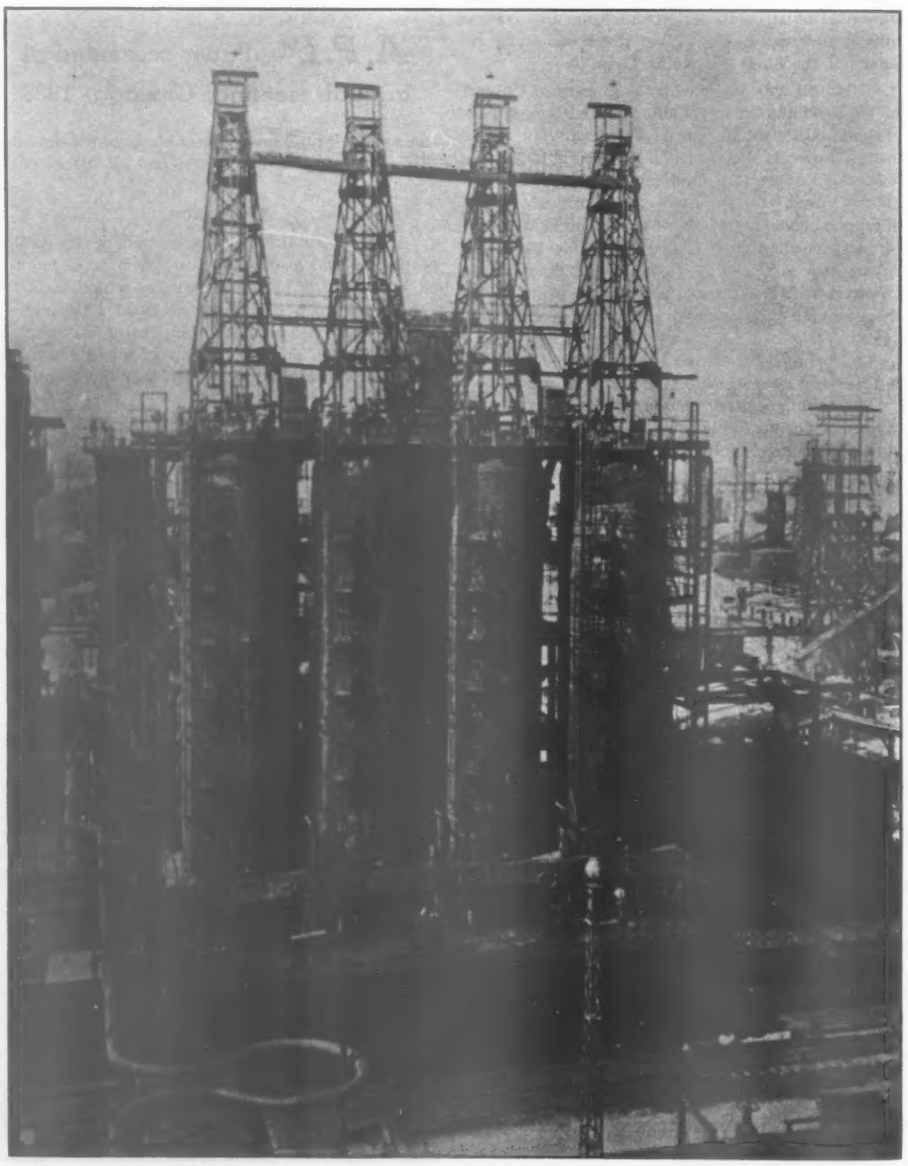

Fig. 2—General view of the four 13-foot by 50-foot coking chambers

Fig. 3—Hydraulic boring tool

from pumping. The indications are that such a system would be cheaper to operate and maintain than the conventional railroad-car system.

Comparison With Cable Method of Removing Coke

The conventional cable-pulling method formerly used required the hanging of cable within the chamber before coking operations could commence, pulling of the cable for disruption of the coke bed following the run, sending men into the chamber for removal of coke adhering to the chamber wall and, finally, rehanging the cable in preparation for the next run.

Removal of coke by the hydraulic method revealed the following advantages over the cable method:

1. The cleanout time for the 13 by 50-foot chambers has been reduced at least 50 per cent, and complete removal of the coke from a chamber within two hours' time is now a frequent oc-

Fig. 4—Hydraulic cutting assembly

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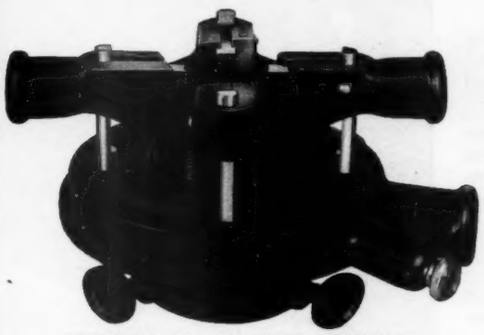

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Both models use a separate set of dies for each size pipe, 2 inch dies are high speed steel, assuring smooth standard taper threads.

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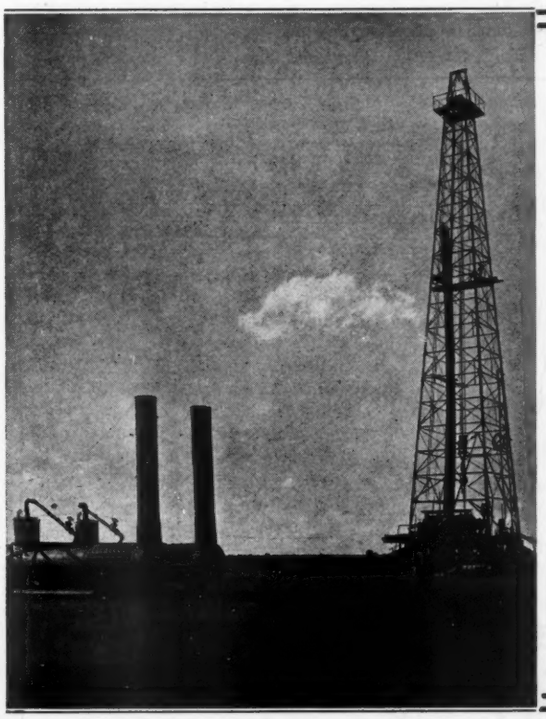

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currence—the record to date being one hour and 40 minutes. Any time saved in clean-out operations usually is an on-stream time gain.

2. The clean-out crew, including the men required for cleaning piping, etc., has been reduced from 20 to 11 men.

3. An important saving has been effected by eliminating the cost of cable, cable clamps, cable hooks, fastening wire, etc.

4. Cable-fastening wire, usually present in coke removed by the cable method, has been eliminated by the hydraulic method—a welcome solution to a marketing problem long sought by those responsible for the screening and marketing of petroleum coke.

5. In the hydraulic decoking method all coke completely is removed from the chamber wall by the hydraulic jets; hence, men are not required to scale the coke from the wall.

6. With the hydraulic method it is not necessary for the clean-out crew to enter the chamber at any time; hence, one of the greatest hazards to health and limb to which this class of labor was formerly exposed has been eliminated.

General

The hydraulic pumps are driven by electric motors especially built for the cycle of operations. A standby high-pressure pumping unit is provided on the Wood River installation.

Experience to date indicates that the cost of maintenance of the jetting nozzles is very low. They are equipped with renewable tips which obviate the necessity for replacing a complete nozzle when wear occurs.

Tests have indicated that the cutting action of the jets has no effect on the steel walls of the vessels.

The swivel joints used in the piping linkage between the high-pressure header and the stem are standard equipment, and the expense for their maintenance to date has been negligible.

The hydraulic method of decoking chambers and the hydraulic method of conveying coke away from chambers are covered by patents and patent applications owned by Shell Development Co., Worthington Pump & Machinery Corp., and the Allen-Sherman-Hoff Co.

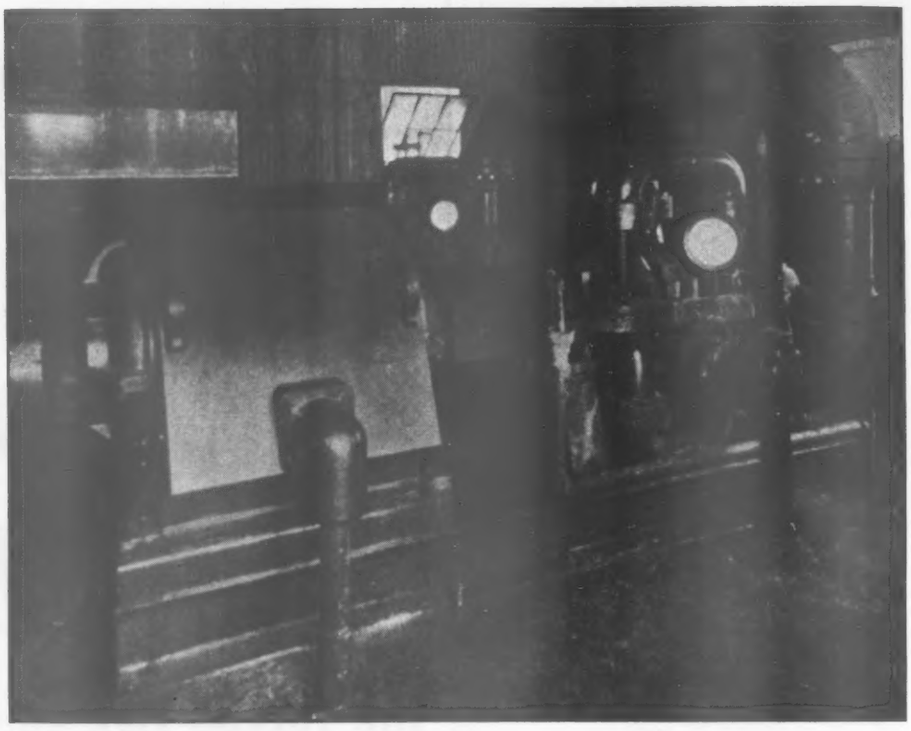

Fig. 5—High-pressure pumps

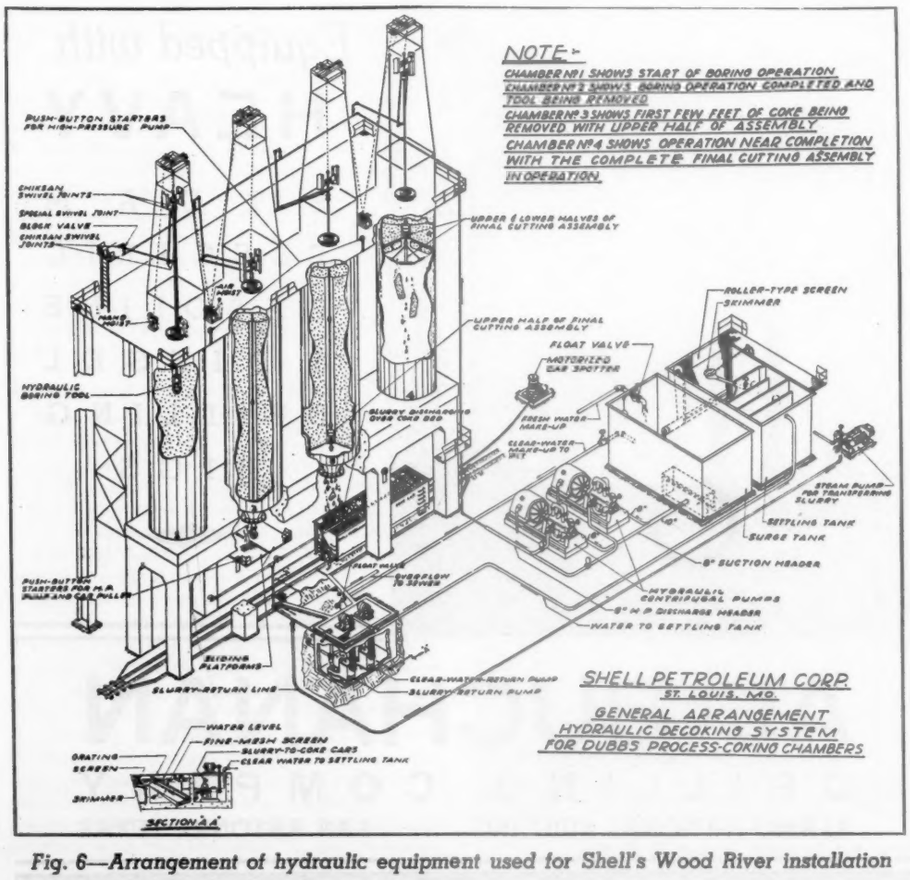

Fig. 6—Arrangement of hydraulic equipment used for Shell's Wood River installation

Reforming Value of Crude From Harper Pool of Texas

The Bureau of Mines has just completed laboratory tests to determine the characteristics and refining value of crude produced in the Harper pool of Ector County, Texas. The data as supplied by the bureau follows:

HARPER POOL, ECTOR COUNTY, TEXAS
GENERAL CHARACTERISTICS OF CRUDE

Specific gravity	0.835
Sulfur, per cent	1.11
Saybolt Universal viscosity at 77° F.	42 sec.
Saybolt Universal viscosity at 100° F.	40 sec.
A.P.I. gravity, degrees	38.0
Color	brownish green

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

Dry distillation. Barometer 742 mm. First drop: 27° C. (81° F.)

Temperature, °C.	Per cent cut	Sum, per cent	°A.P.I. of cut	Viscosity at 100° F.	Cloud test, °F.	Temperature, °F
Up to 50	3.7	3.7	91.3	...	..	Up to 122
50- 75	3.1	6.8	77.8	...	..	122-167
75-100	5.9	12.7	64.5	...	..	167-212
100-125	6.8	19.5	57.4	...	..	212-257
125-150	5.8	25.3	52.7	...	..	257-302
150-175	5.2	30.5	49.7	...	..	302-347
175-200	4.5	35.0	46.7	...	..	347-392
200-225	4.5	39.5	43.4	...	..	392-437
225-250	5.2	44.7	40.2	...	..	437-482
250-275	5.5	50.2	37.0	...	..	482-527
Vacuum Distillation at 40 mm.						
Up to 200	3.7	3.7	32.8	40	15	Up to 392
200-225	5.3	9.0	31.7	49	35	392-437
225-250	5.0	14.0	28.9	62	55	437-482
250-275	4.5	18.5	27.1	97	70	482-527
275-300	5.3	23.8	25.4	175	90	527-572

Carbon residue of residuum 8.3 per cent; carbon residue of crude 1.9 per cent.

APPROXIMATE SUMMARY OF YIELDS

	Per cent	Sp. gr.	°A.P.I.	Viscosity
Light gasoline	12.7	0.685	75.1	.....
Total gasoline and naphtha	35.0	0.740	59.7	.....
Kerosene distillate	9.7	.817	41.7	.....
Gas oil	12.3	.853	34.4	.....
Nonviscous lubricating distillate	9.7	.868-.893	31.5-27.0	50-100
Medium lubricating distillate	6.3	.893-.905	27.0-24.9	100-200
Viscous lubricating distillate	1.0	.905-.907	24.9-24.5	above 200
Residuum	22.8	.964	15.3	.....
Distillation loss	3.2	.....	.....	.....

Solubility and Volume Relation for Three Crudes and Gases

By J. E. GOSLINE and C. R. DODSON

Standard Oil Co. of California, San Francisco, Calif.* Standard Oil Co. of California, La Habra, Calif.

A. P. I.— Paper presented at annual meeting, Chicago, 1938

A knowledge of the physical properties of reservoir fluids is fundamental to a rational treatment of many problems in production engineering. Unfortunately, the behavior of naturally-occurring hydrocarbon systems is extremely complex and, up to the present time, not generally predictable from a knowledge of the composition of the system. Some companies, therefore, have determined experimentally the necessary constants for representative samples of the fluids under question. Such determinations usually are restricted in application to conditions simulating closely those under which the samples were procured, in as much as relatively small variations in composition of material exert an appreciable influence upon certain of the characteristics of the system. In some cases such as, for example, a one-zone reservoir containing undersaturated crude of uniform gravity, a single set of determinations upon representative samples will be applicable to the whole field. Usually, however, where variations in formation gas-oil ratio and gravity occur, determinations upon a series of samples are necessary. Ordinarily, if properly sampled, the results of such determinations reasonably are correlative with gravity of residual crude—thus permitting a close approximation of factors for intermediate conditions.

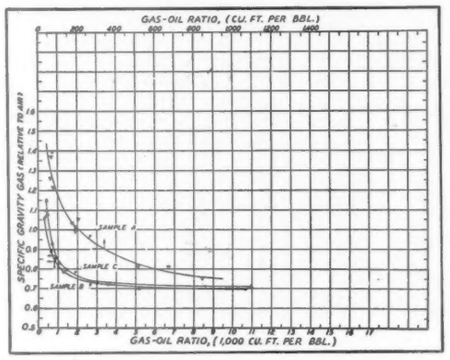

Fig. 1—Relationship between gas-oil ratio and specific gravity of gas

In this paper are presented the results obtained from three mixtures from flowing wells producing from a sand of upper Miocene age in the San Joaquin Valley, California. Of the many possible correlations on an oil-gravity basis, only a sufficient number are presented to indicate the trend of certain of the most commonly used factors. The absolute values must be used with caution for other crudes and gases of the same gravity; because, as has been mentioned previously, total composition has a material influence upon the behavior of the material. The nature of the dependency of certain of the factors upon gravity is believed, however, to be of interest, and perhaps of some quantitative utility to those desiring to estimate factors for conditions in a particular field on a basis of a restricted number of actual determinations.

*Authors' title—Solubility Relations and Volumetric Behavior of Three Gravities of Crudes and Associated Gases.

Sampling and Experimental Procedure

Saturated liquids and excess gas were obtained, in special calibrated cylinders, directly from the high-pressure separators at the well. In each case the separator was operating at a pressure between 400 and 500 pounds.

The variable-volume cell utilized in making the determinations is the same type as developed by Lacey[1] and associates in connection with A.P.I. Research Project 37.

Saturated liquid was transferred directly to the cell for the lowest gas-oil-ratio measurements. Higher ratios were obtained by introducing varying quantities of excess gas. Gas-oil ratios were calculated from direct measurement of gas and residual-oil volumes at the end of a run. The gas was metered off the cell in the same pressure and temperature stages as utilized in the field separation.

Experimental Results

The three crudes investigated had gravities of 35.8, 48.2, and 63.4° A.P.I., and will be referred to in the following discussion as samples "A," "B," and "C," respectively. In as much as for each sample varying amounts of a constant-composition gas were added to saturated trap liquid to alter the gas-oil ratio, the composition of the total gas released from solution at a given pressure and temperature is a function of gas-oil ratio. This relationship is indicated in Figure 1. In this connection, it should be mentioned that, in the authors' opinion, determinations made upon a dead crude by the addition of varying quantities of a constant-composition gas must be applied with caution. In fields producing simultaneously from oil and gas-cap intervals which are in contact, the specific gravity of the produced gas should vary with the gas-oil ratio in somewhat the same manner as indicated by the curves in Figure 1. Experience with a number of determinations from a particular field has indicated that a gas-specific-gravity gas-oil ratio relation determined from a study of a large number of wells producing the same gravity of crude compares extremely well with a similar relation obtained in the laboratory by adding varying amounts of gas obtained from the high-pressure separator to saturated liquid from the same separator.

The range of important variables covered in these tests was as follows:

Sample	Pressure (lbs./sq.in.)	Temperature (°F.)	Gas-oil ratio (cu.ft./bbl.)
A	0-3,000	100-198	175- 836
B	0-3,000	100-191	659-10,690
C	0-3,000	100-199.6	421-10,980

In as much as the questions for which these determinations were made were concerned more with the two-phase region than the liquid region, bubble-point trends were not as completely defined experimentally in some ranges as would have been desirable for the purpose of this paper. However, sufficient data on other mixtures of similar nature have permitted reasonable extrapolation and interpolation throughout these ranges.

Table 1 indicates values of formation-volume factors obtained from large-scale correlation charts of the experimental data. In as much as

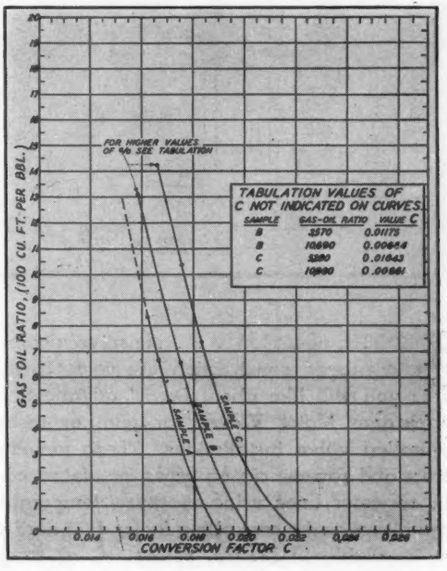
GAS-OIL RATIO, (100 CU. FT. PER BBL.)
FOR HIGHER VALUES OF GOR SEE TABULATION
TABULATION VALUES OF C NOT INDICATED ON CURVES
SAMPLE | GAS-OIL RATIO | VALUE C
B | 3570 | 0.01175
B | 10690 | 0.00644
C | 5320 | 0.01043
C | 10990 | 0.00861
SAMPLE A
SAMPLE B
SAMPLE C
CONVERSION FACTOR C

Fig. 2—Relationship between gas-oil ratio and factor for conversion of formation volume to specific volume

in many flow problems values of specific volume are of importance, the relationship between gas-oil ratio and a conversion factor C given by the equation

$$V = C V_r$$

is indicated in Figure 2. In the above equation

V = specific volume of mixture, cubic feet per lb.

V_r = formation-volume factor, or volume occupied by a unit volume of residual crude when in equilibrium with the specified quantity of gas at the specified pressure and temperature.

Figure 3 indicates a correlation between gravity of crude and specific gravity of gas for various gas-oil ratios. It is to be noted that in the lower oil-gravity and gas-oil ratio range, relatively small changes in oil gravity effect a material alteration in gravity of gas. It is to be expected then that, in these ranges, such factors as solu-

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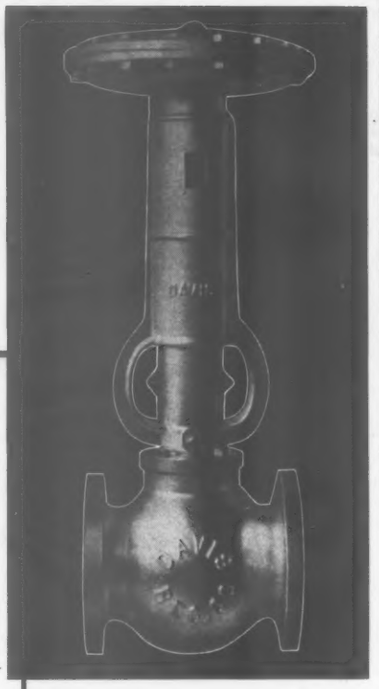

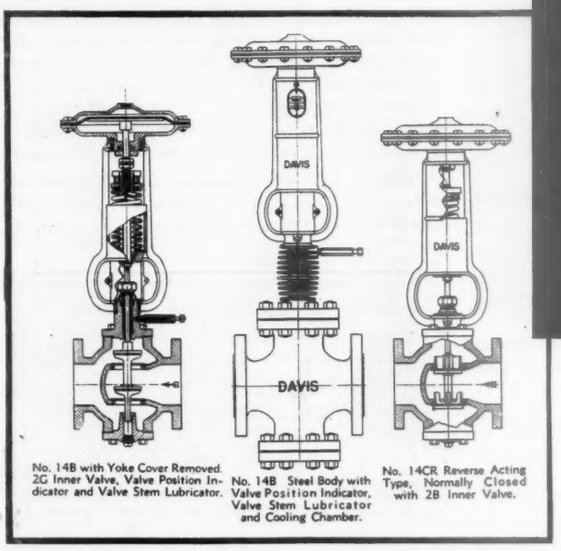

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bility will be influenced materially by this behavior.

Figures 4 and 5 indicate correlations of saturation pressure and residual crude gravities for a series of gas-oil ratios for temperatures of 100 and 200° F., respectively. The indicated departure from approximate linearity of these curves in the lower-gravity higher-ratio range results in part from the more rapid rate of change of gravity of gas with gravity of crude in this same range.

TABLE 1—VALUES OF FORMATION-VOLUME FACTOR

Sample "A"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 175.3†	511.5	667	835.5
100	200	1.93	...	...	...
100	400	1.15	3.09	...	...
100	600	1.14	2.33	2.98	3.67
100	800	1.14	1.85	2.32	2.87
100	1,000	1.13	1.60	1.95	2.35
100	1,200	1.13	1.43	1.72	2.04
100	1,400	1.13	1.33	1.57	1.84
100	1,600	1.13	1.27	1.47	1.70
100	1,800	1.12	1.27	1.40	1.60
100	2,000	1.12	1.27	1.35	1.52
100	2,200	1.12	1.27	1.34	1.46
100	2,400	1.12	1.26	1.34	1.42
100	2,600	1.12	1.26	1.34	1.40
100	2,800	1.12	1.26	1.33	1.40
100	3,000	1.12	1.26	1.33	1.40

Sample "A"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 175.3†	511.5	667	835.5
198	400	1.67	...	...	...
198	600	1.24	2.93	3.41	...
198	800	1.22	2.38	2.91	3.31
198	1,000	1.22	1.99	2.47	2.94
198	1,200	1.21	1.76	2.15	2.60
198	1,400	1.21	1.60	1.93	2.31
198	1,600	1.20	1.48	1.77	2.09
198	1,800	1.20	1.40	1.66	1.94
198	2,000	1.20	1.35	1.57	1.82
198	2,200	1.20	1.35	1.50	1.72
198	2,400	1.19	1.34	1.45	1.65
198	2,600	1.19	1.34	1.43	1.59
198	2,800	1.19	1.34	1.42	1.55
198	3,000	1.18	1.33	1.42	1.51

Sample "B"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 659	1,313	3,570	10,690
100	600	2.58	...	...	...
100	800	1.99	...	10.82	...
100	1,000	1.66	3.21	8.63	...
100	1,200	1.46	2.71	7.07	...
100	1,400	1.33	2.38	5.98	17.33
100	1,600	1.33	2.13	5.20	14.89
100	1,800	1.33	1.96	4.62	13.00
100	2,000	1.32	1.84	4.19	11.59
100	2,200	1.32	1.74	3.84	10.53
100	2,400	1.32	1.67	3.58	9.66
100	2,600	1.31	1.64	3.38	9.02
100	2,800	1.31	1.63	3.22	8.62
100	3,000	1.31	1.63	3.10	8.26
100	3,200	1.30	1.62	3.02	8.00

Sample "B"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 659	1,313	3,570	10,690
149	600	3.04	...	...	...
149	800	2.32	...	...	...
149	1,000	1.92	3.71	10.00	...
149	1,200	1.68	3.15	8.25	...
149	1,400	1.51	2.74	7.02	...
149	1,600	1.40	2.44	6.10	17.62
149	1,800	1.40	2.23	5.42	15.47
149	2,000	1.39	2.08	4.90	13.84
149	2,200	1.39	1.96	4.49	12.54
149	2,400	1.38	1.86	4.16	11.50
149	2,600	1.38	1.79	3.90	10.67
149	2,800	1.38	1.74	3.70	10.04
149	3,000	1.37	1.72	3.54	9.55
149	3,200	1.37	1.71	3.42	9.17

(Continued on Page 192)

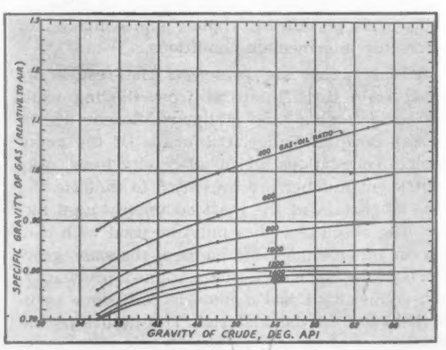

Fig. 3—Effect of crude gravity upon gas gravity for various gas-oil ratios

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Sample "B"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 659	1,313	3,570	10,690
191	600	3.66	...	...	...
191	800	2.61	...	...	...
191	1,000	2.15	...	...	...
191	1,200	1.85	3.56	9.26	...
191	1,400	1.66	3.11	7.87	...
191	1,600	1.52	2.78	6.86	...
191	1,800	1.43	2.51	6.11	17.50
191	2,000	1.43	2.32	5.51	15.66
191	2,200	1.42	2.16	5.04	14.24
191	2,400	1.42	2.03	4.66	13.04
191	2,600	1.41	1.93	4.37	12.09
191	2,800	1.41	1.86	4.15	11.31
191	3,000	1.40	...	3.97	10.69
191	3,200	1.40	...	3.83	10.21

Sample "C"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 421	739	1,042	1,425	5,280	10,980
100	400	1.59	....	....	....	....	....
100	600	1.29	2.66	4.02	5.53	....	....
100	800	1.28	1.99	2.97	4.32	16.15	30.50
100	1,000	1.28	1.61	2.38	3.36	12.12	24.80
100	1,200	1.27	1.47	1.99	2.81	10.00	20.90
100	1,400	1.27	1.47	1.72	2.40	8.40	17.82
100	1,600	1.26	1.46	1.61	2.12	7.21	15.22
100	1,800	1.26	1.46	1.60	1.92	6.35	13.21
100	2,000	1.26	1.45	1.59	1.81	5.66	11.72
100	2,200	1.25	1.45	1.59	1.80	5.17	10.64
100	2,400	1.25	1.44	1.58	1.79	4.76	9.74
100	2,600	1.25	1.44	1.57	1.78	4.43	9.02
100	2,800	1.25	1.44	1.57	1.78	4.23	8.48
100	3,000	1.24	1.43	1.56	1.77	4.13	8.13
100	3,200	1.24	1.43	1.56	1.76	4.07	7.90
100	3,400	1.24	1.43	1.55	1.75	4.01	7.72

Sample "C"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 421	739	1,042	1,425	5,280	10,980
140	400	1.91	4.46	5.96	...	....	....
140	600	1.33	2.95	4.40	6.01	....	....
140	800	1.32	2.19	3.35	4.76	17.85	....
140	1,000	1.32	1.76	2.68	3.81	14.10	28.15
140	1,200	1.31	1.51	2.23	3.18	11.40	23.62
140	1,400	1.31	1.50	1.94	2.72	9.58	20.35
140	1,600	1.30	1.49	1.72	2.38	8.30	17.60
140	1,800	1.30	1.49	1.66	2.16	7.33	15.37
140	2,000	1.29	1.48	1.65	1.98	6.56	13.65
140	2,200	1.29	1.47	1.64	1.89	5.94	12.30
140	2,400	1.28	1.47	1.63	1.88	5.46	11.23
140	2,600	1.28	1.46	1.62	1.86	5.07	10.35
140	2,800	1.28	1.46	1.62	1.85	4.76	9.69
140	3,000	1.27	1.46	1.61	1.84	4.55	9.17
140	3,200	1.27	1.45	1.60	1.83	4.43	8.85
140	3,400	1.27	1.45	1.60	1.82	4.35	8.60

Sample "C"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 421	739	1,042	1,425	5,280	10,980
180	400	2.28	4.90	6.30	...	...	...
180	600	1.49	3.36	4.87	...	...	...
180	800	1.37	2.48	3.71	5.31	...	...
180	1,000	1.36	1.97	2.95	4.31	15.95	31.70
180	1,200	1.36	1.66	2.46	3.55	12.90	26.25
180	1,400	1.35	1.55	2.12	3.03	10.83	22.57
180	1,600	1.34	1.54	1.87	2.66	9.33	19.62
180	1,800	1.34	1.53	1.72	2.38	8.27	17.28
180	2,000	1.33	1.53	1.71	2.17	7.42	15.44
180	2,200	1.33	1.52	1.69	2.01	6.70	13.92
180	2,400	1.32	1.51	1.68	1.97	6.13	12.70
180	2,600	1.32	1.50	1.67	1.95	5.69	11.70
180	2,800	1.31	1.50	1.66	1.93	5.31	10.91
180	3,000	1.31	1.49	1.65	1.92	5.04	10.30
180	3,200	1.31	1.49	1.64	1.91	4.86	9.89
180	3,400	1.30	1.48	1.64	1.89	4.74	9.65

Sample "C"

Temp. (°F.)	Pressure* (lbs./sq. in.)	Gas-oil ratio (cu. ft. per bbl.) 421	739	1,042	1,425	5,280	10,980
199.6	400	2.57	5.12	...	...	...	...
199.6	600	1.64	3.53	5.09	...	...	...
199.6	800	1.40	2.59	3.92	5.56	...	...
199.6	1,000	1.39	2.06	3.05	4.48	16.65	34.80
199.6	1,200	1.38	1.73	2.56	3.69	13.60	28.25
199.6	1,400	1.37	1.57	2.22	3.11	11.57	23.85
199.6	1,600	1.37	1.56	1.95	2.73	10.00	20.65
199.6	1,800	1.36	1.55	1.77	2.45	8.80	18.07
199.6	2,000	1.36	1.55	1.74	2.28	7.83	16.15
199.6	2,200	1.35	1.54	1.72	2.06	7.11	14.62
199.6	2,400	1.34	1.53	1.71	2.00	6.51	13.32
199.6	2,600	1.34	1.52	1.70	1.98	6.03	12.32
199.6	2,800	1.34	1.51	1.68	1.96	5.61	11.49
199.6	3,000	1.33	1.51	1.67	1.94	5.29	10.82
199.6	3,200	1.33	1.50	1.66	1.92	5.09	10.35
199.6	3,400	1.32	1.49	1.66	1.91	4.96	10.04

*All values of pressure are absolute.
†The data for gas-oil ratio = 175.3 is at 225.5° F.

Figures 6 and 7 indicate correlations between gravity of residual crude and bubble-point formation-volume factor for a series of saturation pressures at temperatures of 100 and 190° F., respectively. As a matter of interest, and to emphasize that mixtures of crudes and gases from different sources do not follow necessarily similar trends,

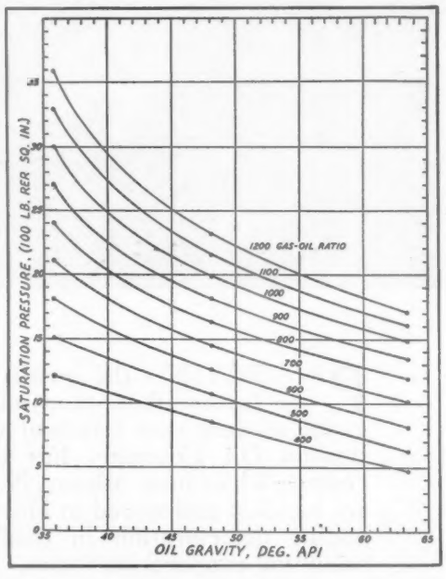

Fig. 4—Effect of oil gravity upon saturation pressure at 100° F.

values obtained from results obtained by Sage and Lacey[2] on a crude with a gravity of 33.9° A.P.I., from the Dominguez field, are also shown in Figures 6 and 7. Our present knowledge of the behavior of hydrocarbon systems is not sufficient to explain with assurance the departure of these values from the indicated trend of the curves. In this instance, however, it is suggested that the apparent lower solubility of the Dominguez gas may account for the differences noted. For example, extrapolation of the curve shown in Figure 4 for a saturation pressure of 2,000 pounds, and for an oil gravity equivalent to that of the Dominguez crude, indicates a solubility slightly in excess of 600 cubic feet per barrel. For the same pressure and temperature, the Dominguez determinations indicated a solubility of only 475 cubic feet per

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barrel. The lower solubility in the case of the Dominguez crude is considered due primarily to

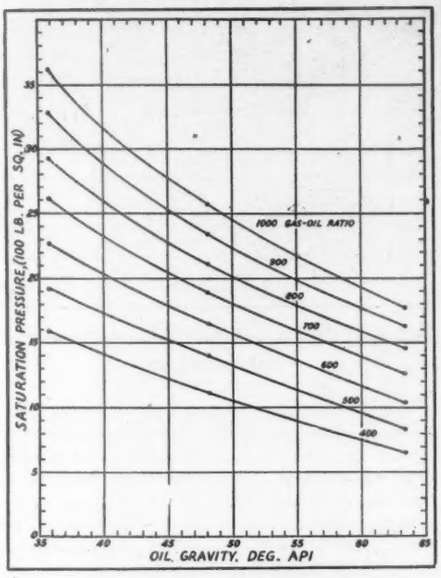

Fig. 5—Effect of oil gravity upon saturation pressure at 200° F.

the lower average molecular weight of the gas utilized—the specific gravity being approximately 0.66 relative to air, as compared to 0.78 for the comparable San Joaquin Valley Miocene sand crude case.

Figures 8 and 9 indicate correlations between gravity of residual crude and formation-volume factor in the two-phase region for a series of gas-oil ratios at two equilibrium conditions. Interpolated data for the Dominguez results again are indicated. It is to be noted that the formation-volume factor decreases with increase in crude gravity—which tendency results mainly from the increase in solubility of gas with gravity of oil. The Dominguez values show better agreement with the correlation in the two-phase region than for bubble-point liquid. In this instance the relative volumes of atmospheric phases are the same in the two cases; the variation in equilibrium volume results from the differences of amount of gas in each phase, the difference in contribution to liquid-phase volume per unit of dissolved gas, and the difference in compressibility of the material in the gaseous phase.

As a matter of interest, it may be mentioned that during the progress of the tests on the three samples some considerable difficulty was encountered at times in obtaining equilibrium of material. This was due to the separation of a second

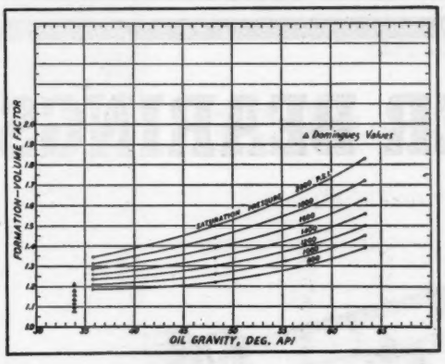

Fig. 6—Effect of oil gravity upon saturated-liquid—formation-volume factor, 100° F.

liquid phase of an asphaltic nature. It was impossible, with the type of apparatus and methods employed, to delimit the range of conditions over which this material dropped out—although there

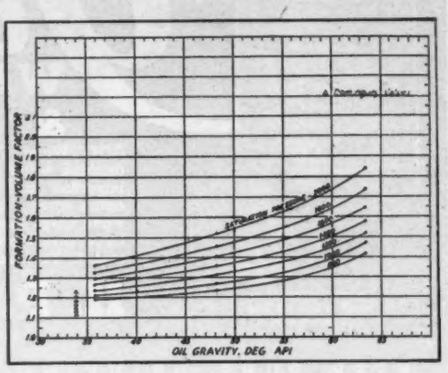

Fig. 7—Effect of oil gravity upon saturated-liquid—formation-volume factor, 190° F.

was evidence that it was fairly persistent. Sage, Webster, and Lacey[3] encountered a similar condition in connection with addition of methane to a composite Santa Fe Springs crude, and the authors have had like experiences with crude and gases from various San Joaquin Valley fields. An asphaltine type of substance has been encountered as a hard, black dissemination within the cores of producing sands from one of these fields, and several gradations in consistency of similar material is deposited in the flow strings and connections of wells producing from this field. Unfortunately, the exact cause of the separation of this additional phase is not well understood. It may be due to insolubility of certain of the higher-

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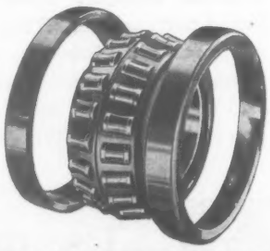

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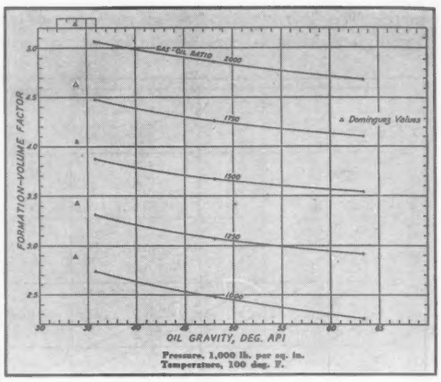

Fig. 8—Effect of oil gravity upon formation-volume factor

molecular-weight components in the liquid phase resulting from change in total composition of the system or from changes in equilibrium pressure and temperature at constant total composition. The practical importance of this property of certain types of naturally-occurring hydrocarbon systems, in so far as it may reflect considerable loss in productivity of wells as well as accumulation in equipment, would indicate the desirability of a more complete understanding of the phenomenon.

Acknowledgement

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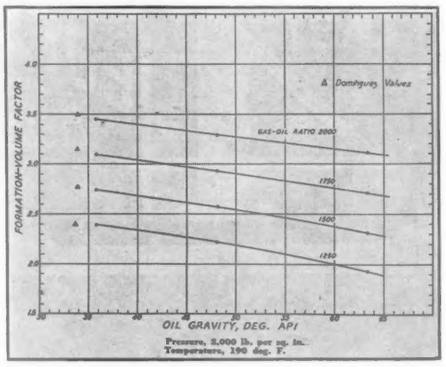

Fig. 9—Effect of oil gravity upon formation-volume factor

Pecos Refinery Sold

The Pecos Refining Co. plant at Pecos, in Reeves County, and the 34-mile, 6-inch line from the plant to the Hendricks Ranch pool of Winkler County, all in West Texas, have been sold to El Paso Iron & Metal Co. and W. Silver, both of El Paso, for an unnamed price.

The refinery, a subsidiary of the West Texas Refining Co. of Dallas, is to be dismantled. It is a 5,000-bbl. outfit, with skimming and Jenkins cracking unit, and was built in 1928. The two 55,000-bbl. storage tanks at the refinery are also being taken down.

The sale was made through Harry L. Skelly, oil man of Tulsa, who acted as joint agent for both the West Texas company and the Skelly Oil Co., which held an interest in the plant and owned the pipe line.

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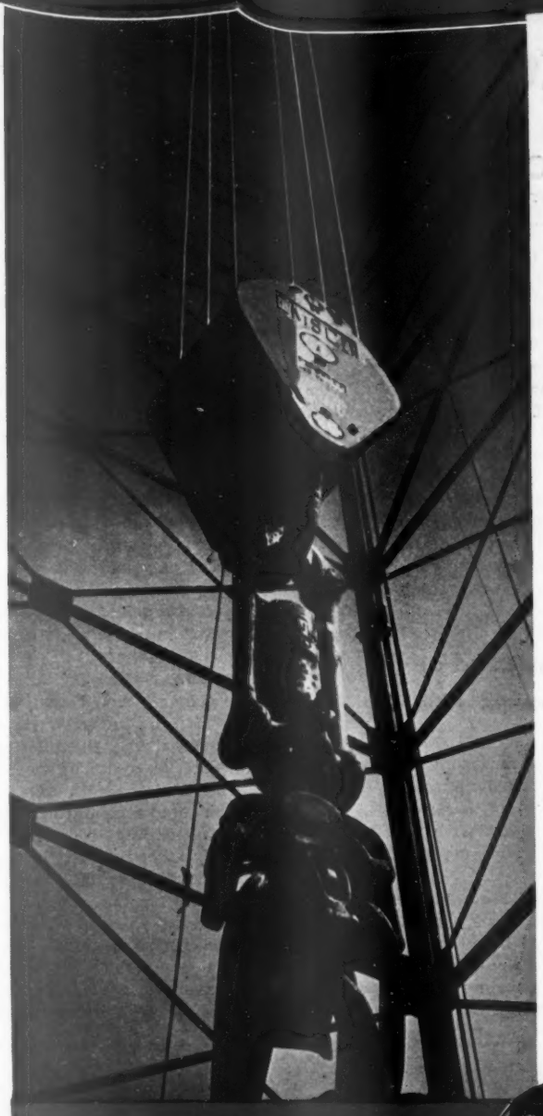

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CONTINENTAL

Venting Requirements for Low-Pressure Oil-Storage Tanks

By LOUIS BOSA
Shand & Jurs Co., Berkeley, Calif.*

It has become rather general practice in the petroleum industry to use gas-tight tanks for the storage of the more volatile crude and refined products, equipping them with pressure and vacuum breather valves as a means of minimizing vapor losses due to thermal breathing or displacement by oil movements into or out of the tanks.

Manufacturers of venting equipment furnish capacity curves for their valves, from which a user can select the number and size of valves required for a given installation—provided he can determine the volumetric breathing requirement for that installation. Most users have established their own methods for computing such volumetric requirements but, unfortunately, there is little agreement among the various methods and factors employed. This became very evident in a recent investigation conducted in cooperation with members of the Institute's Committee on the Standardization of Steel Tanks for Oil Storage and with members of the Institute's committees on fire prevention — which investigation also brought to light the desire of a large number of oil companies to work out some standard method of calculation, flexible enough to fit varying conditions, economical from the standpoint of the amount of venting equipment required, yet having at the same time a sufficient margin of safety to recommend it as a *safe* standard.

Based Upon Questionnaire

As the initial step in the investigation to which we have referred, a questionnaire was sent to a number of the larger oil companies in regard to the methods used by them for the calculation of venting requirements. The information received was tabulated and studied, and then there was worked out a proposed standard method considering both available experimental data and current practice.

But, before reviewing the results of this investigation and the proposed standard method, let us state briefly the main factors involved in the problem of tank venting.

Evaporation losses can be placed in three classifications, viz.: losses due to daily temperature variations; filling losses, inherent to the operations of filling and emptying; and windage losses due to the circulation of air in and out of a tank if there are cracks in the roof seams, if the roof openings are not vapor-tight, or if the tank is equipped with free vents.

In ordinary cone-roof tanks breathing and filling losses cannot be prevented entirely, but the windage losses and those due to minor temperature and barometric variations can be eliminated by the use of pressure and vacuum breather valves—provided, of course, the tank is otherwise made vapor-tight. The potential savings are of sufficient magnitude that they cannot be disregarded. These savings can be accomplished even with the usual small pressure and vacuum settings of 1 inch of water, and justify the trend toward slightly higher settings whenever the type of tank construction permits. There is no doubt that pressure and vacuum breathers have demonstrated their economic justification in the field of low-pressure storage.

Our immediate concern is the problem of the proper determination of the number and size of breathers to be used in any particular installation. Experience shows that insufficient venting capacity may lead to unsatisfactory operating conditions, and may defeat the purpose of reducing the evaporation losses for which pressure and vacuum breathers are installed. Insufficient breathing capacity may, indeed, lead to the development of leaks in the seams of the roof by allowing the internal pressure to build up to such an extent that the plates from the rafters are lifted up; or it may result in the collapse of the roof, or of the upper ring of the tank, because of excessive vacuum within the tank. The latter has not been an uncommon occurrence.

***A.P.I.*— Paper presented at annual meeting, Chicago, 1938**

In the proper determination of breathing requirement we have a dual problem: one phase is the determination of the required breathing capacity; the other is the choice of the equipment that will make available, at a certain pressure and vacuum, such breathing capacity.

The required breathing capacity depends upon a number of well-recognized factors. Under normal breathing conditions the principal factors involved are:

(*a*) The volume of the vapor space.

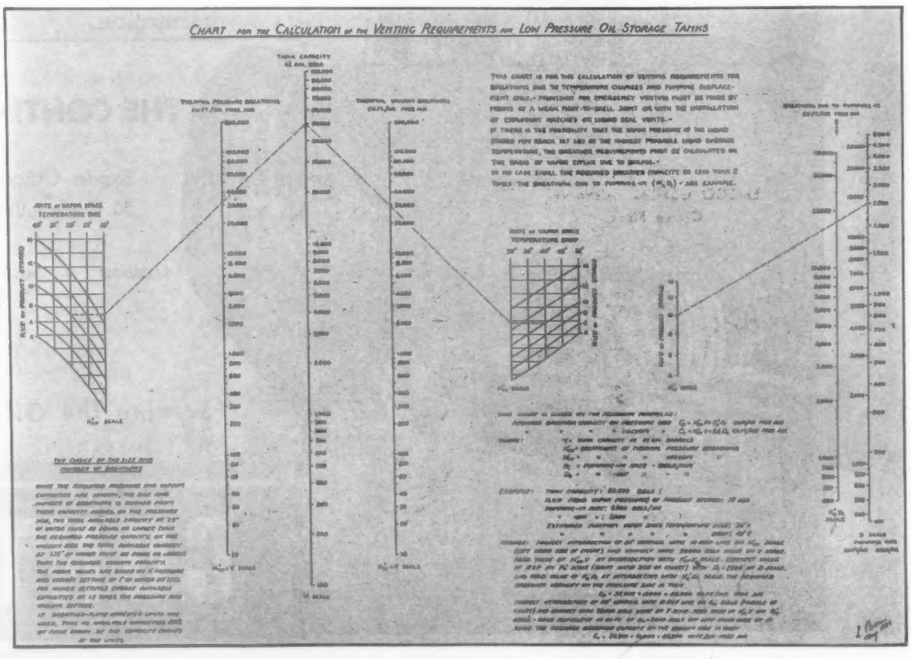
(*b*) The vapor pressure of the liquid stored.

(*c*) The rates of filling and emptying, or pumping rates.

(*d*) The maximum rates of temperature rise or temperature drop of the tank vapor space and of the liquid surface.

We are omitting purposely two other factors, viz.: vapor efflux, due to boiling; and emergency venting, due to exposure fire—because the first must be considered only in the case of high vapor-pressure products, for which cone-roof tanks are not the most suitable; and the second is usually dealt with separately, and taken care of by means other than equipment of the type used for normal breathing requirements.

It should be evident—and it has been shown experimentally—that, for a given liquid vapor pressure and pumping rate, the highest rate of breathing will take place under the combined conditions of a tank being almost empty and subjected to the most rapid temperature rise or temperature drop. Specifically, for what we may call the pressure breather requirements of a tank, the most adverse condition will be brought about by the most rapid rise in the temperature of the vapor space occurring when the almost empty tank is being filled at the maximum rate. In the case of "vacuum breathing," the most severe combination of adverse conditions is represented by a rapid drop of the temperature of the vapor



*Author's title—The Calculation of Venting Requirements for Low-Pressure Oil-Storage Tanks.

space occurring in an almost empty tank which is being emptied at the maximum rate.

As to the importance of vapor pressure in the phenomenon of breathing, it can be shown theoretically—and it has been observed in actual tests—that the amount of breathing increases with increased liquid vapor pressures.

In the choice of the venting equipment we are usually guided by capacity curves, either computed or determined experimentally and furnished by the equipment manufacturer.

Present Methods for the Calculation of Venting Requirements

While the foregoing represent what are felt to be basic factors in the problem of tank venting, and which have been, on the whole, considered by every company that has established its own rules for the determination of venting requirements, their manner of application has varied widely, as can be seen from a study of Table 1.

In Table 1 is condensed the information received from a number of the larger oil companies regarding the methods which they use for the calculation of breather requirements. Even a cursory examination of this table shows that the current practice in breather-requirement calculations, although based in general on the same fundamental principles, leads to quantitative interpretations quite at variance with each other. This is brought out by the examples shown in columns 11, 12, 13 and 14, where four cases have been worked numerically on the basis of information

1	2	3	4	5	6	7	8	9	10	11	12	13	14
			Basis for Venting-Requirement Calculations						Four Examples of Application of the Various Methods				
Company	Location of Tanks	General Considerations	Temperature Change (Deg. F.)	Pumping In and Out	Others	Do They Use Safety Vents as Distinct from Breather Valves?	Do They Use Flame Arresters ?	Accepted Available Relief-Valve Capacities		144 ft. 46 ft. 1¾ in.	120 ft. 40 ft. 7¼ in.	102 ft. 29 ft. 3½ in.	60 ft. 40 ft. 10½ in.
A	Pacific Coast	Use charts based on tank vapor-space content of air only. Vapor pressure is not taken into consideration because of wide range in charcteristics of different oils stored or handled. Factor of 2 applied to assumed temperature change takes care of the higher values of vapor pressure with the exception of very high-gravity gasolines, which are treated as a special problem.	Base.....30 Multiplier.....2 Total.....60	Maximum pumping rate without multiplier.	Emergency venting is taken care of, preferably by the use of separate liquid-seal emergency valves.	YES (Liquid-seal.)	On vapor recovery only.	Manufacturer's rating at an operating pressure of ¾ oz. per sq. in.	Tank diameter Tank height Tank capacity, bbl. Tank capacity, cu. ft. Pumping rate, bbl. per hour Pumping rate, cu. ft. per hour Temperature breathing Pumping Total required capacity Valves required (capacity rating at ¾ oz. per sq. in.) (Add to these the liquid-seal emergency vents.)	144 ft. 46 ft. 1¾ in. 134,000 750,000 4,000 22,400 90,000 22,400 112,400 Two 8-in.	120 ft. 40 ft. 7¼ in. 83,000 460,000 2,000 11,200 56,000 11,200 67,200 Two 8-in.	102 ft. 29 ft. 3½ in. 43,500 238,000 2,000 11,200 29,000 11,200 40,200 One 8-in.	60 ft. 40 ft. 10½ in. 20,500 115,000 1,000 5,600 14,000 5,600 19,600 One 4-in.
B	Atlantic Coast and Gulf Coast	Breathing due to temperature changes is figured basically on a 60-deg. rise of temperature in the vapor space with the tank half full. A 60-per-cent increase is allowed for evaporation due to this rise in temperature. All this is equivalent to a required breathing capacity of 6.6 per cent of the nominal tank volume. Vapor pressure not taken into account. Use free vents where no material vaporization takes place.	Base.....40 Multiplier.....1.6 Total.....65 (Applied to one-half the tank volume, equivalent to 6.6 per cent *total* tank volume.)	Maximum pumping rate. Multiplier 2, to allow for emergency venting, unusual vapor surges, etc.		NO Believes breathers have sufficient margin of safety. Rely on foam system of fire protection.	YES, but omit them on high-flash-point material.	Manufacturer's rating. For flame-arrester combination units, manufacturer's rating reduced 20 per cent to allow for some clogging. Available capacity chosen at following pressures: Roof Pitch (Inches Per Foot) / Valve Setting / Available Vent Capacity (Ounces Per Square Inch) 1½ / Pressure 1.15 / 3 1½ / Vacuum 0.5 / 1.75 <1½ / Pressure 0.5 / 1.5 <1½ / Vacuum 0.5 / 1	Temperature breathing Pumping Total required capacity Valves required (capacity rating at 1¾-oz. vacuum)	40,500 44,800 94,300 One 8-in.	20,400 22,400 53,800 One 6-in.	15,700 22,400 33,100 One 6-in.	7,600 11,200 18,800 One 4-in.
C	General	The basic temperature change is chosen according to tank location. Vapor pressure not taken into account.	Pacific Coast.....20 Great Lakes.....25 Atlantic Coast.....30 Salt Lake.....30 Mid Continent.....40 Rocky Mountains.40 Mexico.....40 Gulf Coast.....50 (No multiplier)	Maximum pumping rate without multiplier.		NO	YES, but omit them on high-flash-point material.	Assume for ½-oz. pressure setting: For free vents, 70 per cent of 12-in. pipe-nipple capacity. For combination vent and flame-arrester, 35 per cent of 12-in. pipe-nipple capacity. A correction is made to allow for deviations in manufacturers' capacity charts from the 100-per-cent efficient pipe nipple. (Nipple capacity chosen at 1 oz.)	PACIFIC COAST: Temperature breathing Pumping Total required capacity Valves required (at 70-per-cent capacity, 12-in. pipe nipple) GULF COAST: Temperature breathing Pumping Total required capacity Valves required	30,000 22,400 52,400 One 8-in. 73,000 22,400 97,400 One 10-in.	16,400 11,300 29,600 One 6-in. 46,000 11,300 57,300 One 8-in.	9,500 11,200 30,700 One 6-in. 23,800 11,300 35,000 One 8-in.	4,800 5,600 10,300 One 4-in. 11,500 5,600 17,100 One 6-in.
D	Gulf Coast	Venting equipment is based on the in-breathing rather than out-breathing; tanks are, therefore, equipped with units of the size and number necessary to permit the maximum in-breathing rate without creating excessive vacuum (maximum allowable, 6 in. of water). Theory based on actual records of temperature changes. Vapor pressure not taken into account.	Use formula $C = 3.6\,S$ (S = surface of tank enclosing vapor space). Based on maximum recorded temperature drop of 7 deg. in 9.08 min.	Maximum pumping rate without multiplier.	Vent sizes based on in-breathing rather than out-breathing, as with tank spacing used exposure fire would not create a temperature rise comparable to assumed temperature drop.	NO	YES	Manufacturer's rating, but doubling pressure drop through flame arrester to allow for some clogging. No such correction, however, is made for tanks in sales service handling clean oil. Choose capacity at vacuum of not more than 4 in. of water.	Tank-shell area, S $C = 3.6\,S$ Pumping Total required capacity Valves required (capacity at vacuum rating of 4 in. of water)	37,000 133,000 22,400 155,400 One 10-in.	27,000 97,000 11,200 108,200 One 8-in.	17,500 63,000 11,200 74,200 One 8-in.	10,500 38,000 5,600 43,600 One 8-in.
E	Mid Continent and Great Lakes	Have discontinued the use of breather valves, because do not believe that 1 oz. to 2 oz. pressure is sufficient to save enough evaporation loss to pay for the extra cost of the fittings. Most of the new tanks are equipped with free vents and flame-arrester units.					YES: believe main value of most of venting units in market lies in their flame arresters. (See "General Considerations.")						
F	Pacific Coast	Provide for a classification of oils according to their vapor pressure. Class I: Vapor pressure in excess of 14 lb. per sq. in. Class II: Vapor pressure between 2 and 14 lb. per sq. in. Class III: Vapor pressure less than 2 lb. per sq. in. (Vapor pressure is Reid at 100 deg. F., or pressure at stored temperature if this exceeds 100 deg. F.)	Base.....30 Multiplier.....5 Total.....150 (1,100 cu. ft. of air per hour per each 1,000 bbl. of tank capacity.)	Pumping-in rate with multiplier 2. Pumping-out rate without multiplier.	*Class I:* Relief capacity, either pressure or vacuum, equals 100 per cent of sum of pumping and temperature breathing. *Class II:* Relief capacity, either pressure or vacuum, equals 75 per cent of sum of pumping and temperature breathing. *Class III:* Relief capacity, either pressure or vacuum, equals 50 per cent of sum of pumping and temperature breathing. (Open vents used.)		On vapor recovery only.	For the purpose of selecting the proper size and number of vent connections, assume that the flow capacities of individual tank connections are as follows: Vent Diameter (Inches) / Air (Cu. Ft. Per Hour) 4 / 15,000 6 / 35,000 8 / 65,000	(Class II) (Selection according to pumping-in breathing.) Temperature breathing Pumping-in breathing Total required capacity Valves required (see column 9)	110,000 33,600 143,600 Two 8-in. and One 4-in.	67,000 16,800 84,400 One 8-in. and One 4-in.	35,000 16,800 51,800 One 8-in.	17,000 8,400 25,400 One 6-in.
G	Atlantic Coast Gulf Coast Great Lakes	Base the capacity of vent valves only on the breathing due to pumping in and out, on an assumption that such capacity is more than ample for breathing due to temperature changes. The multiplier 2 used for the pumping rate is based on extensive series of tests. (See paper in Sect. II of the *Proceedings of the Ninth Annual Meeting of the American Petroleum Institute*, January 3, 1929.)	Not taken into account.	Pumping rate with multiplier 2.		NO	YES	Manufacturer's rating. Pressure not stated.	Temperature breathing Pumping Total required capacity Valves required (capacity rating at ¾-oz. pressure)	44,800 44,800 One 8-in.	22,400 22,400 One 8-in.	22,400 22,400 One 8-in.	11,200 11,200 One 8-in.
H	General	Do not state what method is used for the determination of the required breathing capacity due to temperature changes and to pumping. Manufacture own valves.			Assume a 60-deg. temperature rise due to exposure fire with tank almost empty.		NO	Manufacture their own valves; capacity determined by test.					

Company	Location of Tanks	General Considerations	Basis for Venting-Requirement Calculations: Temperature Change (Deg. F.)	Pumping In and Out	Others	Do They Use Safety Vents as Distinct from Breather Valves?	Do They Use Flame Arresters ?	Accepted Available Relief-Valve Capacities
L	Mid Continent	For the determination of the capacity required for pumping, take into consideration also the area of the oil surface.	Base.....20 (No multiplier)	Pumping rate without multiplier.	Add 3 cu. ft. for each square foot of oil surface in calculation of required pressure-venting capacity.		?	?
M	Atlantic Coast and Gulf Coast	Venting calculations based on observed maximum rate of temperature drop of 1 deg. per min. in tank vapor space during thunder shower on hot summer day.	On vacuum side, 1 deg. F. per min. On pressure side, ½ deg. F. per min.	Pumping rate without multiplier.	Emergency venting is taken care of by partly weakening the joint between roof and shell. †	NO	?	Own tests have shown capacity curves furnished by manufacturer to be correct. Available vent capacity chosen at ½ oz., pressure or vacuum. (Note:—With the usual valve setting of ½ oz., the capacity at ½ oz. is 0, or nearly so.)
N	Pacific Coast	Maximum daily vapor-space temperature range is deduced from experimental chart in function of the maximum daily atmospheric-temperature range for same location. Total daily breathing is then calculated on the basis of thermal expansion and vapor-pressure variation. Maximum rate of breathing (required capacity) is deduced from experimental curve of total breathing against time.	See "General Considerations."	Pumping rate without multiplier.		YES (Liquid-seal.)	NO	Choice of number and size of valves is made from chart based on method outlined in column 3 and on capacity tests on all valve sizes. This chart is used only for tanks containing products well below the boiling point when in storage. The valve sizes shown in columns 11, 12, 13, and 14 were chosen from such a chart.

	10	11	12	13	14
	Four Examples of Application of the Various Methods				
	Tank diameter	144 ft.	120 ft.	102 ft.	60 ft.
	Tank height	46 ft. 1¾ in.	40 ft. 7¼ in.	29 ft. 3½ in.	40 ft. 10½ in.
	Tank capacity, bbl.	134,000	83,000	43,500	20,500
	Tank capacity, cu. ft.	750,000	460,000	238,000	115,000
	Pumping rate, bbl. per hour	4,000	2,000	2,000	1,000
	Pumping rate, cu. ft. per hour	22,400	11,200	11,200	5,600
	Temperature breathing	90,000	56,000	29,000	14,000
	Pumping	22,400	11,200	11,200	5,600
	Total required capacity	112,400	67,200	40,200	19,600
	Valves required (capacity rating at ¾ oz. per sq. in.)	Two 8-in.	Two 8-in.	One 8-in.	One 4-in.
	(Add to these the liquid-seal emergency vents.)				
	Temperature breathing	40,500	20,400	15,700	7,600
	Pumping	44,800	22,400	22,400	11,200
	Total required capacity	94,300	53,800	38,100	18,800
	Valves required (capacity rating at 1¾-oz. vacuum)	One 8-in.	One 6-in.	One 6-in.	One 4-in.
PACIFIC COAST	Temperature breathing	30,000	16,400	9,500	4,800
	Pumping	22,400	11,300	11,200	5,600
	Total required capacity	52,400	29,600	30,700	10,300
	Valves required (at 70-per-cent capacity, 12-in. pipe nipple)	One 8-in.	One 6-in.	One 6-in.	One 4-in.
GULF COAST	Temperature breathing	73,000	46,000	23,800	11,500
	Pumping	22,400	11,300	11,200	5,600
	Total required capacity	97,400	57,300	35,000	17,100
	Valves required	One 10-in.	One 8-in.	One 8-in.	One 6-in.
	Tank-shell area, S	37,000	27,000	17,500	10,500
	$C = 3.6\,S$	133,000	97,000	63,000	38,000
	Pumping	22,400	11,200	11,200	5,600
	Total required capacity	155,400	108,200	74,200	43,600
	Valves required (capacity at vacuum rating of 4 in. of water)	One 10-in.	One 8-in.	One 8-in.	One 8-in.
	(Class II) (Selection according to pumping-in breathing.)				
	Temperature breathing	110,000	67,000	35,000	17,000
	Pumping-in breathing	33,600	16,800	16,800	8,400
	Total required capacity	143,600	84,400	51,800	25,400
	Valves required (see column 9)	Two 8-in. and One 4-in.	One 8-in. and One 4-in.	One 8-in.	One 6-in.
	Temperature breathing	44,800	22,400	22,400	11,200
	Pumping	44,800	22,400	22,400	11,200
	Total required capacity	44,800	22,400	22,400	11,200
	Valves required (capacity rating at ¾-oz. pressure)	One 8-in.	One 8-in.	One 8-in.	One 8-in.

	10	11	12	13	14
	Four Examples of Application of the Various Methods				
	Tank diameter	144 ft.	120 ft.	102 ft.	60 ft.
	Tank height	46 ft. 1¾ in.	40 ft. 7¼ in.	29 ft. 3½ in.	40 ft. 10½ in.
	Tank capacity, bbl.	134,000	83,000	43,500	20,500
	Tank capacity, cu. ft.	750,000	460,000	238,000	115,000
	Pumping rate, bbl. per hour	4,000	2,000	2,000	1,000
	Pumping rate, cu. ft. per hour	22,400	11,200	11,200	5,600
	Temperature breathing	30,000	18,400	9,500	4,800
	Pumping	22,400	11,300	11,200	5,600
	Surface evaporation	49,000	34,000	24,500	8,800
	Total required capacity	101,400	63,600	45,200	18,700
	Valves required (rating at ¾-oz. pressure)	Two 8-in.	Two 8-in.	One 8-in.	One 4-in.
	Temperature breathing (vacuum)	90,000	55,300	28,600	13,800
	Pumping-out breathing	22,400	11,300	11,200	5,800
	Total required capacity	112,400	66,800	39,800	19,600
	Valves required (rating at ¾-oz. vacuum) †	Three 8-in.	Two 8-in.	One 8-in.	One 6-in.
		Two 8-in.	One 8-in.	One 8-in.	One 6-in.

	10	11	12	13	14
	Examples of Application of Proposed Standard Method				
Reid vapor pressure = 5 lb.	Thermal pressure breathing	48,000	29,000	16,000	7,800
	Pumping-in breathing	25,800	12,800	12,800	6,200
	Capacity required on pressure side	73,800	41,800	28,800	13,700
Rate of temperature rise: 25 deg. F.	Thermal vacuum breathing	53,000	33,000	17,000	8,100
	Pumping-out breathing	22,800	11,200	11,200	5,700
	Capacity required on vacuum side	75,800	44,200	28,200	13,800
Rate of temperature drop: 25 deg. F.	Breathers required. Determined by:	One 10-in. Either	One 8-in. Vacuum condition	One 6-in. Vacuum condition	One 6-in. Vacuum condition
Reid vapor pressure = 12 lb.	Thermal pressure breathing	118,000	76,000	40,000	19,800
	Pumping-in breathing	28,500	14,500	14,500	7,100
	Capacity required on pressure side	146,500	90,500	54,500	26,600
Rate of temperature rise: 35 deg. F.	Thermal vacuum breathing	100,000	68,000	36,000	17,800
	Pumping-out breathing	22,800	11,200	11,200	5,700
	Capacity required on vacuum side	131,500	79,200	47,200	23,200
Rate of temperature drop: 50 deg. F.	Breathers required. Determined by:	One 10-in., One 8-in. Pressure condition	One 10-in. Either	One 8-in. Vacuum condition	One 8-in. Either

Table 1

° The required capacity for emergency venting is determined on the basis of the expansion of the tank vapors due to the heat input through one-half of the tank shell for an arbitrary difference in temperature between outside and inside of the tank. The emergency vents, of the liquid-seal type, are set at a pressure slightly higher than that of the breather valves, but well under the allowable working pressure of the tank (usually ¾ oz. per sq. in.).

† In cases of uninsulated pressure storage, the required vent capacity due to exposure fire is based on the vapor expansion calculated on the basis of a heat input of 8,000 B.t.u. per sq. ft. per hour through the exposed tank-shell area. This is the shell area up to the 20-ft. elevation for vertical cylindrical drums and for horizontal cylindrical or spherical vessels whose maximum diameter is more than 20 ft. from the ground; but, if the maximum diameter of the last two is less than 20 ft. from the ground, the exposed surface is the shell area up to the maximum diameter.

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When there is a ground fire on the tank farm, or a pipe line connection is broken off at a tank flange—almost anything can happen if the storage tank is not equipped with an Internal Safety Valve.

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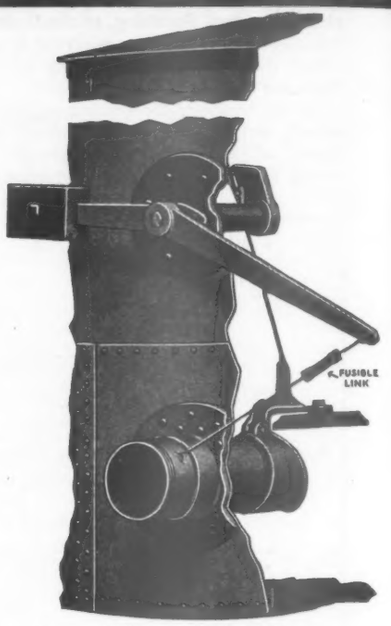

Figure S T—709

This internal safety valve has a valve disc mounted on a counterweighted arm which is held in the open position by a cable attached to a fusible link outside the tank and the melting of which releases the cable and closes the valve which is held tightly closed by head pressure. The stuffing box can be installed as closely as 18" above the valve for floating roof tanks and in the top shell plate above the liquid level of cone roof tanks.

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Figure S T—1640

This is a steel valve designed for bulk station use, equipped with an extra strong spring which precludes pumping into any tank of a battery except the one whose valve is open. This construction makes it unnecessary to install a gate valve on the tank exterior as with Figure S T—885.

Figure S T—885

This is an all bronze spring loaded valve which screws into the tank spud and is held open by a fusible link, the melting of which automatically closes the valve. Being spring loaded it provides for the relief of any thermal expansion in the lines back into the tank.

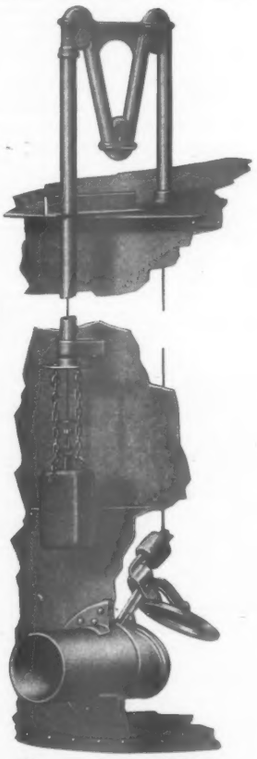

Figure S T—605

This valve has a disc mounted on a counterweighted arm and is held open by a cable attached to a fusible link outside the tank. The cable runs through a gas tight cable sheave case mounted on the tank roof, which obviates all difficulties associated with stuffing boxes.

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received. The choice of the size and number of breathers required has been based on a set of arbitrary capacity curves which represent a fair average of capacity curves published by various manufacturers (Fig. 1).

Every effort has been made to apply correctly the methods of calculation as outiined in the communications received from the various oil companies; but it is possible that in one or two cases the numerical application is not correct, because the proper interpretation of the particular method was doubtful.

Certain other considerations which became available in assembling data for Table 1 are of interest. Only one of the companies listed holds the opinion that the savings in evaporation losses, considered possible with the installation of pressure- and vacuum-relief valves, do not compensate for the extra cost of the fittings over that of open free vents.

One of the formulas used gives the required capacity not in function of tank volume, but in function of shell area. This is interesting: because, other conditions being equal, the volume of breathing, in proportion to the volume of the tank, may be expected to be greater for a small tank than for a large one.

In another case no account is taken of breathing due to temperature changes—it being assumed that the capacity calculated on the basis of the maximum pumping rate, multiplied by 2, is sufficient to take care of breathing under all other conditions.

Except for the foregoing two cases, all companies of the group examined base their capacity calculations on thermal expansion due to temperature changes, and on the pumping rate.

In Column 4 are tabulated data relative to the assumed rate of temperature change, which is used in the computation of the volumetric variation of the vapors, considered as perfect gases. No fair comparison can be made regarding the hourly rates of temperature variations assumed in the different methods as a basis for the calculation of temperature breathing. This hourly rate, including the multiplier, if any, varies from 20 degrees to 100 degrees, and various factors might be included in it as, for instance, geographic location, vapor pressure, and general safety factor. Only two companies state specifically that the basic rate of temperature changes is to be chosen according to the geographic location of the tank.

As is shown in Column 5 covering breathing due to pumping, a multiplier of 2 for the maximum pumping rate is used by some of the companies (not the majority) to allow for unusual vapor surges or otherwise as a general safety factor, or to take into account conditions that have nothing to do with pumping.

A classification according to the vapor pressure of the liquid stored is made in only one of the methods analyzed. This does not necessarily mean that the vapor pressure has not been taken into consideration in the other methods. It means, undoubtedly, that the methods have been based on the highest possible value of vapor pressure of the liquid to be stored, or no differentiation was thought worthwhile between high or low vapor pressures.

In only three instances a definite statement has been made with reference to the distinction to be made between pressure and vacuum operation; and in one of these the breather requirements are determined according to the vacuum condition.

For the determination of breather sizes, the calculation of the capacity required is only one side of the problem. The available capacity is a function not only of breather size, but also of pressure (or vacuum) setting, and of the pressure in the tank. It will be noted (Table 1, Column 9) that the available capacity is chosen according to varying values of pressure (or vacuum) which in most cases are evidently selected on a basis of having a sufficient margin of safety.

Finally, nowhere is there any direct mention of the necessary reduction to standard air of the volume of air and vapor mixture going through the pressure-relief valve, which has a density greater than 1 (air = 1). This reduction is necessary in view of the fact that the rated capacities of breather valves are given in volumes of standard air.

It is not surprising that the four numerical examples worked out in Table 1 give variations up to 350 per cent in the required capacities; and, if the number and size of breathers required do not show a similar range, this is due in part to different criteria used in the choice of the available capacity, and in part to the fact that the step in capacity between one size breather and the next is so large that it allows greater flexibility in the calculation of the required capacity.

From the analysis of the data contained in Table 1, it appears that the disagreement existing among the various methods is due principally to the uncertainty regarding the numerical values to be assigned to the factors involved. This suggests immediately that a standard method be proposed which will be based, as far as practicable, on sound theoretical considerations, yet giving results which will not show too great variance from conditions that experience to date has shown to be reasonably satisfactory. In order to make it acceptable generally it must have sufficient flexibility to take into account the largest possible range of actual conditions, and it must also include a sufficient margin of safety so that it can be accepted as a really safe standard. Flexibility is desirable if economy, as well as the safety of the installation, is to be achieved; as it is evident that the breather requirements of a tank containing a high vapor-pressure product are greater than those of a tank containing a material of low vapor pressure—while some differentiation should be made for the geographic location of the tank.

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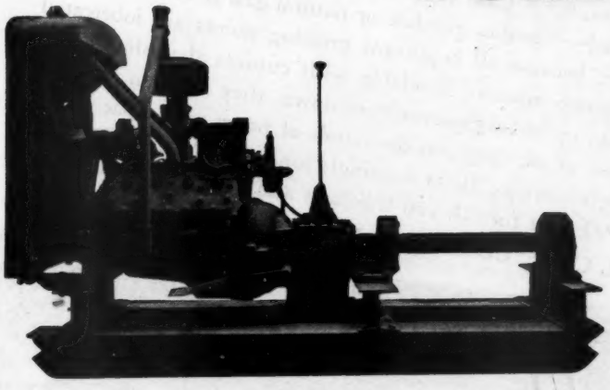

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taking into account the different rates of temperature changes.

Based on these general principles, a proposed standard has been evolved. The detailed derivation of this method is given in the appendix. The proposed standard is based on the following considerations:

(*a*) For pressure, the required breathing capacity is taken as the sum of the thermal pressure breathing for the almost empty tank, due to highest probable rate of temperature rise, and of the breathing due to pumping in.

(*b*) For vacuum, the required capacity is taken as the sum of the thermal vacuum breathing for the almost empty tank, due to the highest possible rate of temperature drop, and of the pumping-out rate.

(*c*) The following factors are, therefore, pertinent, and must be available for every study of breathing requirements:

1. The volume of the tank (capacity in barrels).

2. The Reid vapor pressure of the product stored (in pounds per square inch at 100° F.).

3. The maximum probable rates of temperature rise and temperature drop in the vapor space of the almost empty tank (in degrees Fahrenheit per hour).

4. The rates of filling and emptying (in barrels or cubic feet per hour).

The appended nomographic chart constructed on the basis of the proposed standard method affords a simple means for the computation of the required breathing capacity.

Thermal pressure breathing is determined on the left-hand side of the chart by projecting the intersection of the proper Reid vapor-pressure line with the vertical line corresponding to the selected rate of temperature rise onto the K'_{TP} scale; a line from this point to the tank capacity read off the V scale will intersect the $K'_{TP} \times V$ scale at a point which gives the required thermal pressure breathing.

The breathing due to pumping in is read off the $K'_d \times D_1$ scale, at the right-hand side of the chart, at the intersection with the line joining the proper points on the K'_d and D scales. The sum of the above two values is the required capacity on the pressure side in cubic feet of free air per hour.

Similarly, the required capacity on the vacuum side is the sum of the thermal vacuum breathing and of the pumping-out rate. The first is read off the $K'_{TV} \times V$ scale in the center of the chart in a manner identical to that outlined for the thermal pressure breathing; the second is read, in cubic feet, directly off the D scale.

Particular attention is called to one exception, which is the case of small tanks with relatively high pumping-in rate—where the thermal pressure breathing might be less than the breathing due to pumping. In this case the required pressure capacity should be taken at least as twice the breathing due to pumping in.

The hourly rates of temperature rise and temperature drop in the vapor space of an almost empty tank are among the four factors necessary for breather-requirement calculations. The actual values to be assigned to them in any particular case are at times uncertain, because the available data refer usually to tanks full or almost full. These rates are often selected according to main geographic subdivisions as, for instance,

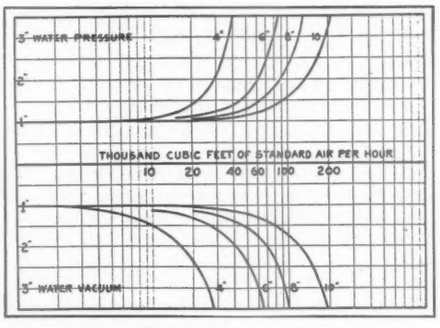

Fig. 1—Typical capacity curves of pressure and vacuum breathers

Pacific Coast, Atlantic Coast, Mid-Continent, and Gulf Coast—all of which are too general. A cooperative effort seems, therefore, to be desirable in order to pool all available data on the subject, and in order to gather new data, so that in time a map could be compiled showing the maximum recorded rates of temperature rise and temperature drop in the areas of interest.

In general, the rate of temperature drop, due to a sudden shower on a hot summer day, should be chosen 10 degrees or 15 degrees higher than the rate of temperature rise.

Selection of Venting Equipment

Breathing-capacity requirements determined from the chart correspond to the two most severe combinations of adverse conditions, and the probability that these may ever be realized is remote. However, it seems proper that the venting equipment be chosen so that sufficient pressure and vacuum capacities are available at tank pressure and tank vacuum to eliminate definitely any possibility of damage to the tank.

On the pressure side, it is important to avoid the lifting of the roof plates from the rafters on account of excessive pressure, as this may lead to the development of leaks in the seams and joints and to an unnecessary increase of evaporation losses. The three-sixteenths inch roof plates used in standard tank construction weigh approximately 0.85 ounces per square inch, which is equivalent to 1.5 inches of water. If the venting equipment is selected according to the capac-

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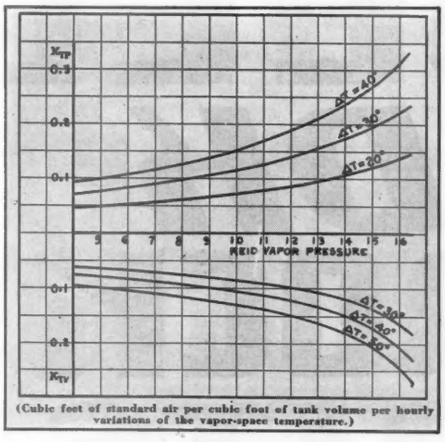
ity available at 1.5 inches of water, there will be an ample margin of safety to protect against rupture of the roof. On the vacuum side, we must allow a sufficient margin of safety to protect the tank from collapsing under excessive vacuum.

As far as the roof is concerned, the design live load for tanks of A.P.I. standard construction is 25 pounds per square foot, which corresponds to 4.8 inches of water. Beyond this load there is a margin of safety, indicating adequate strength in the roof itself. Rather uncertain, however, is the determination of the resistance to collapse of the shell under vacuum. The application, to the top course of large tank shells, of the empirical formulas giving the collapsing pressure for thin cylinders under external pressure, gives values of the order of 1 inch to 2 inches of water. While it is doubtful whether these formulas can be applied to tank shells, there can be no doubt that collapse is retarded by the stiffening action of the top angle, and of the roof itself. In Table 1 is shown that two of the companies listed ("B" and "D") choose the vacuum-capacity rating, respectively, at 3 inches and not beyond 4 inches of water vacuum. These values may be considered by some as being too high, but must be taken into consideration as an indication



(Cubic feet of standard air per cubic foot of tank volume per hourly variations of the vapor-space temperature.)

Fig. 2—Coefficients K_{TP} of thermal pressure discharge and K_{TV} of thermal vacuum intake

of actual practice. Considering all factors then, it seems to be safe to recommend that the available vacuum capacity be chosen at 1.75 inches of water vacuum.

The above refers to the general case of standard tanks wherein the setting of the relief valves is 1 inch of water pressure or vacuum. There are, however, cases in which the construction of the tank permits the adoption of higher pressure and vacuum settings. The choice of the available capacities can then be made at points of the capacity curves corresponding to values of pressure or vacuum selected with considerations similar to the above; but if there is any uncertainty, it is safe to recommend that the choice be made at values of pressures and vacuum equal to 1½ times the pressure or vacuum settings.

Examples of Applications of the Proposed Standard Method

At the bottom of Table 1 are shown some numerical applications of the proposed standard method: one set for low values of Reid vapor pressure and low rates of temperature changes; and one set for high Reid vapor pressure and high rates of temperature changes. The number and sizes of breathers have been chosen by means of the typical capacity curves in Figure 1 for a pressure and vacuum setting of 1 inch of water.

It can be seen from these examples that at times either the pressure condition or the vacuum condition may be the determining factor in the choice, or both conditions may apply equally.

It is considered good general practice to install a number of smaller breathers rather than one large one, and such practice should be particularly recommended in a tentative standard.

Breather—Flame-Arrester Units

A breather–flame-arrester unit has a greatly reduced capacity compared to the breather alone. If a reliable capacity curve for the combined unit is not available, it can be derived from the curves of each component taking into consideration the sum of the pressure drops through the two fittings corresponding to the same capacities. Flame arresters are subject to some clogging; and, while for tanks in sales service handling clean products no sensible reduction in capacity may be expected, in other cases a 20 per cent reduction at least should be made in the capacity of the combination unit.

Vapor Efflux Due to Boiling

If at some probable temperature of the liquid surface the vapor pressure of the liquid stored equals atmospheric pressure, evaporation is greatly accelerated by boiling. Vapor efflux will be greatest when the tank is almost full and the rate of evaporation can be calculated, taking into consideration the heat input (solar radiation and convection) and the latent heat of vaporization of the product stored. The number and size of breathers then can be determined according to the required capacity so calculated, plus pumping

(Continued on Page 206)

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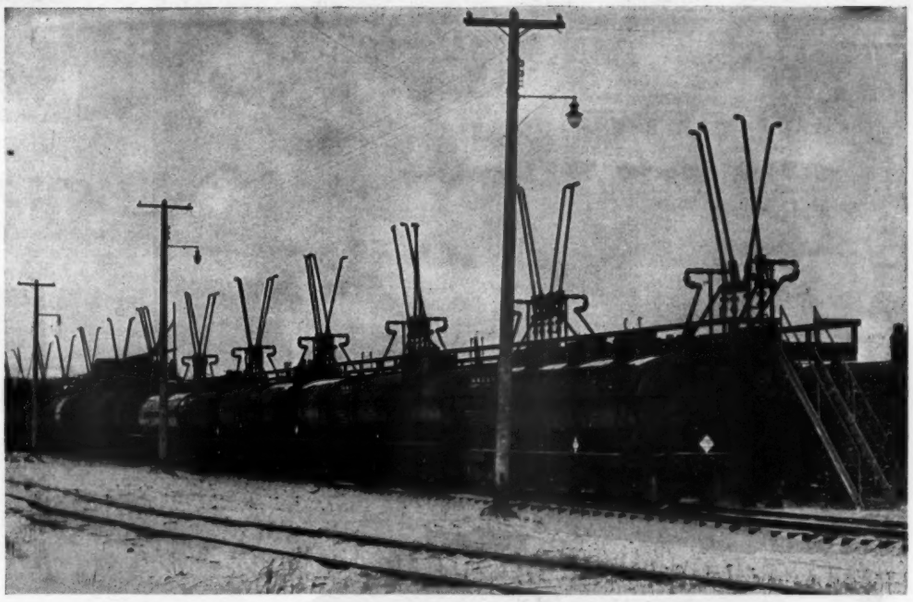

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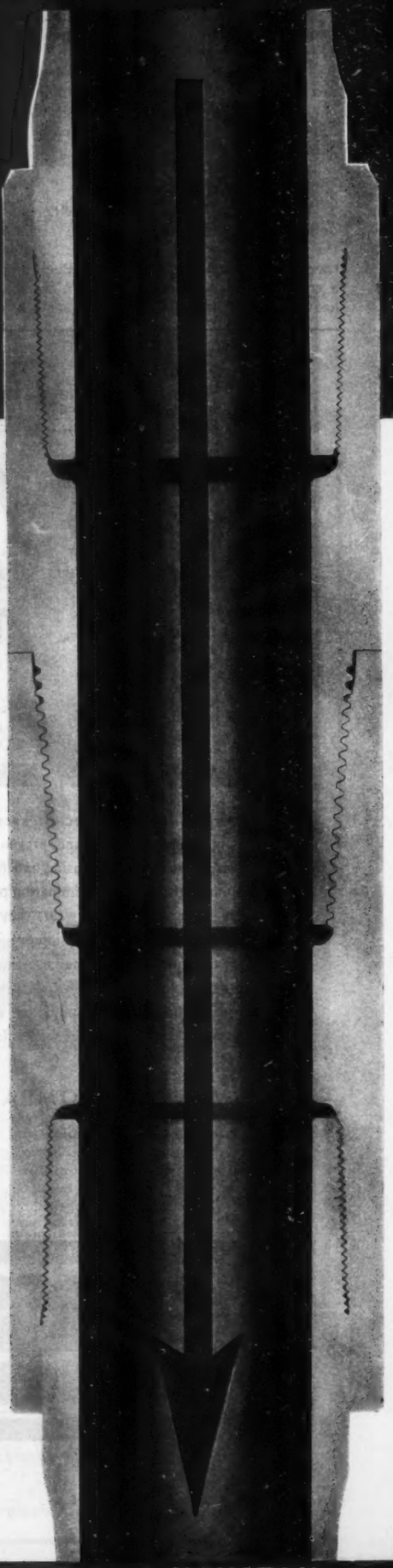

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displacement. A density coefficient will have to be introduced for the usual reduction to standard air.

Emergency Venting

The N.F.P.A. "Suggested Ordinance for the Handling of Flammable Liquids" states that, for vertical tanks with cone roofs having a slope of less than 2½ inches per foot, no emergency vents are required. On horizontal tanks and on vertical tanks with cone roofs having greater than a 2½-inch pitch, the schedule proposed in the N.F.P.A. ordinance can be used for guidance.

Conclusion

The tentative standard method which has been outlined has been based on broad assumptions, the details of which are more fully shown in the appendix of this paper. More than following a strictly thermodynamic treatment, we have endeavored to work out a method which, while simple in its application, is at the same time flexible enough to make it acceptable generally. Moreover, it has been worked out in such a manner that its application to specific cases is in reasonable agreement with available experimental data and with current practice.

It is evident, however, that in order to make such a method workable fully, it must be integrated with reasonably accurate data regarding rates of temperature rise and fall for various areas.

In respect to the actual breathers themselves, everyone is familiar with the capacity curves furnished by the manufacturers. In the main they have been found to be reliable; but the question may be raised in some minds whether they can be trusted implicitly, and if the data so furnished are directly comparable.

A first source of confusion arises from the use of two different pressure units: ounces per square inch, and inches of water. In dealing with low-pressure tanks, agreement on the exclusive use of the "inch of water" as a standard pressure unit would be most desirable.

Another source of confusion is due to the fact that capacity curves as furnished by the manufacturers do not always correspond to the same pressure setting and, consequently, capacity curves of the same size breathers are not always directly comparable. A third source of doubt lies in the lack of knowledge of how these capacity curves have been obtained. In this connection, the suggestion is offered that the capacities of pressure and vacuum breathers and other similar tank equipment be determined according to some well-established test procedure—either by the manufacturers themselves, or by some neutral body. One of the specifications of the test procedure should be a standard pressure and vacuum setting (1 inch of water, for instance); it would then be desirable to carry out a sufficient number of tests to determine what variation in the capacity curves is brought about by a change in the valve settings.

The conclusions of this study may be summed up in the following proposals:

(*a*) Adoption of the proposed standard method as a "tentative standard" to be modified or integrated by the results of a certain period of actual application.

(*b*) Establishment of a clearing house for the collection and correlation of experimental data relative to tank venting, with particular reference to maximum recorded rates of temperature variations.

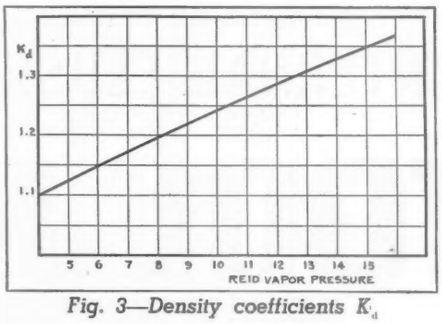

Fig. 3—Density coefficients K_d

(*c*) Agreement on the use of the "inch of water" as a standard pressure unit for low-pressure storage tanks.

(*d*) Establishment of a well-defined test procedure for the determination of the flow characteristics of breathers and similar venting equipment.

APPENDIX

Tank breathing is due to variations of the thermal conditions inside the tank, or to volumetric displacement due to the operations of filling and emptying. In the first case we have either pressure or vacuum thermal breathing (corresponding to a rise or to a drop in temperature); in the second case we have pumping-in or pumping-out breathing.

Thermal Breathing

If the vapor space contained an homogeneous perfect gas, the changes in volume due to temperature variations could be determined quickly by the application of the perfect-gas law. However, the vapor space contains a mixture of air (an almost perfect gas) and gasoline vapors; and to the latter the perfect-gas law does not apply, because they are in a condition of equilibrium with the liquid. A unit volume of air and vapor mixture in the tank vapor space may be considered as containing two equal unit volumes of air and vapors, each at a certain partial pressure. The sum of these partial pressures is the total pressure of the mixture (Dalton's law). The total pressure, which is the pressure existing in the tank vapor space,

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varies between the narrow limits defined by the settings of the pressure- and vacuum-relief valve, and in low-pressure tanks can be considered constant and equal to 14.7 pounds per square inch. The partial pressure p of the vapors is a function of the temperature of the liquid surface, and is independent of the total pressure of the mixture. Consequently, for a certain value of this temperature the partial pressure of the air is the difference, or 14.7—p.

When the temperature of the vapor space and the temperature of the liquid surface change on account of changing atmospheric conditions, there is a change in both the temperature and the pressure conditions of the air contained in the vapor space.

Pressure Thermal Breathing

The volume of discharge can be determined with sufficient accuracy by the application of the perfect-gas law to the air only. In the case of a temperature rise a volume V of air, that initially has a temperature T_1 (absolute) and a partial pressure $14.7-P_1$, undergoes a volumetric variation according to the equation:

$$V' - V = [(\frac{T_2}{T_1})(\frac{14.7-P_1}{14.7-p_2}) - 1]V \qquad (1)$$

where T_2 is the final temperature of the vapor space, and p_2 is the final partial pressure of the vapors. As a reasonable approximation, Equation 1 may be said to represent the volume to be discharged through the pressure-relief valve for a volume V of the vapor space.

The air and vapors contained in the volume of discharge are directly proportional to the respective partial pressures. It is then possible to determine the density of the mixture discharged, which must be expressed in volume of standard air in order to permit a comparison with the rated capacities of pressure and vacuum breathers. Some assumption would have to be made regarding the composition of the vapors contained in the vapor space. We shall assume that the average tank vapors contain butane, pentane, and hexane vapors in the following proportions:

	Per cent	Density (air=1)
Butane	50	2
Pentane	35	2.48
Hexane	15	2.97

This assumption is based on the average composition of tank vapors in several Pacific Coast installations. Analyses of the air-vapor mixture in tanks containing crude oil in the Mid-Continent area show large percentages of ethane and propane. These vapors have lower densities than those considered in the above assumption and would, consequently, lead to a lower value of the density of the air-vapor mixture. The assumption made is probably conservative in the majority of cases, and variations from the above percentages would not affect greatly the final results.

The density of an air and vapor mixture where p is the partial pressure of the vapors would then be:

$$d = \frac{p}{14.7}[(0.5)(2) + 0.35(2.48) + 0.15(2.97)] + \frac{14.7-p}{14.7} \qquad (1)$$

$$= 2.318\frac{p}{14.7} + \frac{14.7-p}{14.7} = 0.09p \qquad (2)$$

The flow capacity of vents for gases other than air is inversely proportional to the square root of the density; consequently, the discharge expressed in volume of standard air will be:

$$\sqrt{d}(V'-V) = \sqrt{d}[(\frac{T_2}{T_1})(\frac{14.7-p_1}{14.7-p_2}) - 1]V = K_{TP}V \qquad (3)$$

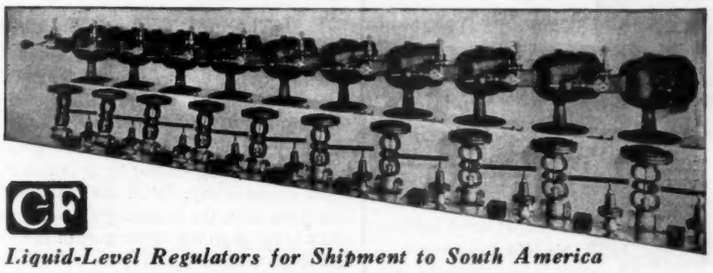
cubic feet of standard air.

K_{TP} can be termed a "coefficient of thermal pressure discharge," while $\sqrt{d}$ can be termed a "density coefficient."

In Figure 2 are shown three curves of the coefficients of thermal pressure discharge plotted against values of Reid vapor pressure. Each curve refers to 20°, 30°, and 40°, respectively, of vapor-space hourly temperature rise.

In order to arrive at the actual numerical values of the coefficient, the values of vapor pressures (derived for each Reid vapor pressure from a Cox vapor-pressure chart) have been plotted, for more accurate reading, on plain cross-section paper against temperature. The assumption was made that, in the initial condition, the vapor space was saturated fully, with a partial pressure of the vapors equal to the liquid vapor pressure at a surface temperature of 75° F. It was then assumed that for each 10° of vapor-space temperature rise, the actual partial pressure of the vapors existing in the vapor space was that corresponding to 0.75° rise of the liquid surface temperature. The final vapor pressures were, consequently, read off the vapor-pressure–temperature chart at 76.5°, 77.25°, and 78°, respectively. It was assumed further that to this final vapor pressure corresponded a condition of full saturation of the vapor space. It is probable that the rise of the liquid surface temperature is larger than the above, but certainly there would be a lag in the full saturation of the vapor space, so that the final partial vapor pressure in the vapor space would be less than that corresponding to the actual value of the liquid surface temperature.

The choice of the initial vapor surface temperature (75° F.) is purely arbitrary; but, for an almost empty tank, is representative of average temperature conditions in the early hours of the hot-



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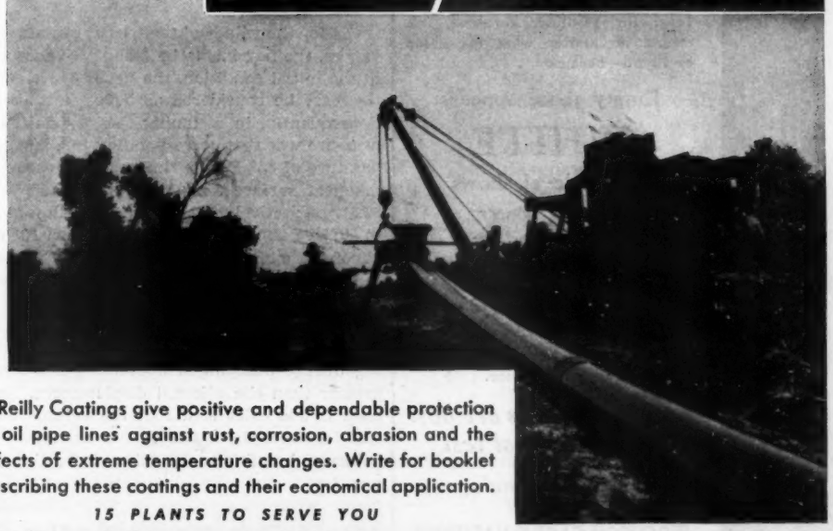

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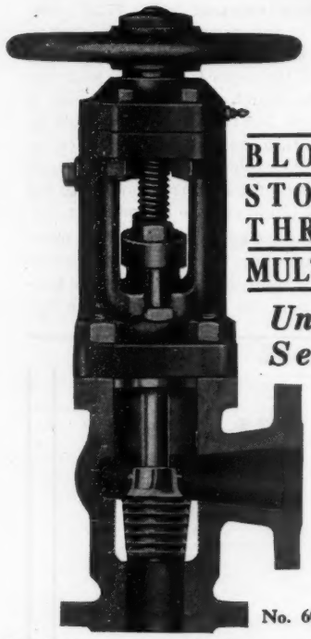

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test summer day. The final vapor pressures were chosen so that the formula would fit the results of some tests which recorded the daily volume of breathing from tanks located on the Pacific Coast—which tanks contained both low- and high-pressure products, and some of which tanks were almost empty and some almost full. The corresponding temperature records were also available. The same *daily* temperature ranges were introduced in the formula as *hourly rates* of temperature change, and the final vapor pressures were chosen in such a way as to obtain calculated breathing volumes in line with the recorded daily volumes of breathing. The fact, however, was taken into account that the volume of breathing during a 24-hour period is larger than that over a one-hour period if the temperature ranges are the same; this is due to the fact that, over a longer period of time, the degree of saturation of the vapor space will be greater.

Thermal Vacuum Breathing

A thermal vacuum condition is created in a tank when there is a decrease in the temperature of the vapor space, and eventually also a decrease in the temperature of the oil surface.

The most severe case is that represented by a temperature drop caused by a thunder shower on a hot summer day. With the creation of vacuum inside the tank, the incoming air will tend to spread like a blanket on the upper part of the vapor space, and its saturation with vapors will take place later. Evidence to this effect is shown in the pressure curves of tanks that have been subjected to a sudden shower on a hot summer day. These curves show a rapid drop from pressure to vacuum followed by a rise from vacuum to pressure—which would indicate precisely the phenomenon outlined above. With a sufficient approximation, we can then say that the volume of air to be admitted into the tank for a volume V of the vapor space is:

$$V - V' = [1 - (\frac{14.7 - p_1}{14.7 - p_2})(\frac{T_2}{T_1})]V = K_{TV}V \quad (4)$$

cubic feet for each cubic foot of vapor space, where T_1 and T_2 are the initial and final temperatures (absolute) of the vapor space, and p_1 and p_2 are the initial and final partial pressures of the vapors. Equation 4, like Equation 1, is derived from the application of the perfect-gas law to the air contained in the vapor space. No correction for reduction to volume of standard air is deemed worthwhile, and K_{TV} can be termed a "coefficient of thermal vacuum intake."

In Figure 2 are shown three curves of the coefficient K_{TV} plotted against values of the Reid vapor pressure. Each curve refers to 30°, 40°, and 50°, respectively, of hourly vapor-space temperature drop.

As for the values of the partial pressures of the vapors, the fact has to be taken into account that, in the initial condition, the vapor space cannot in this case be considered as being saturated fully. Consequently, in assuming that the initial vapor pressure was that corresponding to a surface temperature of 85° F., the final vapor pressures were taken at surface temperatures of 83.5°, 83°, and 82.5°, respectively; i.e., there was allowed a drop in surface temperature of ½° for each 10° drop in vapor-space temperature, instead of ¾° as assumed in the case of the thermal pressure discharge.

Pumping-in Breathing

Numerous tests have shown that the out-breathing during pumping-in operations has a volume greater than the effected displacement. In some tests it was calculated that the volume breathed was 1.4 times the displacement, exclusive of temperature breathing. In other tests the volume breathed varied from 1.14 to 2.49 times the displacement, with an average of 1.66—although this breathing could have included normal thermal breathing.

The explanation is that, when oil is pumped into a tank in which the vapor space is not saturated fully, the agitation of the liquid will promote further evaporation—increasing, therefore, the partial pressure of the oil vapors and, consequently, forcing an additional volume of air and vapor mixture through the vent in excess of the volume equivalent to the pumping displacement.

For the purpose of required breather-capacity calculations, the most severe case is the combination of pumping-in operation at the maximum rate together with the thermal pressure breathing that we have already analyzed. For this thermal pressure breathing we have considered the case of the almost empty tank with a vapor space saturated fully at the temperature of the oil surface. It is permissible, therefore, to introduce in our calculation the volumetric displacement due to pumping in with but one multiplier; i.e., the density coefficient K_d, in order to reduce "volume of air and vapor mixture displaced" to "volume of standard air."

The values of this density coefficient K_d are given in Figure 3. They were calculated for vapor pressures at average vapor-space temperature conditions.

Total Required Capacity

The total breathing capacities required, respectively, on the pressure and on the vacuum side can then be calculated with the formulas:

$$C_p = K_{TP}V + K_dD_1 \quad (5)$$

$$C_v = K_{TV}V + D_o \quad (6)$$

Where: V is the volume of the tank in cubic feet; D_1 and D_o the pumping-in and the pumping-out rates in cubic feet per hour; and the other symbols have meaning already explained.

To facilitate the numerical computations, a nomographic chart has been prepared that in a few and simple steps gives the values of the required breather capacities. This chart is based on Equations 5 and 6 rewritten as follows:

$$C_p = K'_{TP}V + K'_dD_1$$

$$C_v = K'_{TV}V + 5.6D_o$$

Where V, D_1, and D_o are expressed in barrels instead of cubic feet. Full instructions how to use the chart are contained both in the chart itself and in the text.

Acknowledgment

The present study was made possible through the active cooperation of the late W. M. Giffen and of C. C. Ashley, chairman of the Institute's Committee on the Standardization of Steel Tanks for Oil Storage. Basic data were furnished by the following companies: The Atlantic Refining Co., Chicago Bridge & Iron Co., Continental Oil Co., Gulf Oil Corp., Pure Oil Co., Shell Oil Co., Sinclair Oil Co., Standard Oil Co. of California, Standard Oil Development Co., Texas Co., Tide Water Associated Oil Co., and the White Eagle Oil Co.

The writer particularly is indebted for assistance and helpful criticism to the following gentlemen: H. J. Wilson, Tide Water Associated Oil Co.; A. J. Alstrom, Standard Oil Co. of California, and C. J. Nobmann, Shell Oil Co.

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Propane in Manufacture of Pennsylvania Motor Oils

By W. B. McCLUER, J. T. DICKINSON and H. O. FORREST
Kendall Refining Co. M. W. Kellogg Co.

The facts indicate the Pennsylvania refiner has a distinct need for processing methods which will permit him to produce larger quantities of neutral, or the equivalent, from the crude and at the same time reduce the quantity of bright stock. The present and relatively nonflexible yields which are obtained by conventional refining methods frequently result in the building up of huge bright stock inventories because the demand for neutral and lighter products dictates the quantity of crude run to stills. High stock inventories and reasonable margins of profit for refining do not generally go hand in hand.

Larger quantities of neutral or distillate stocks may be obtained from the crude, of course, simply by distilling to higher viscosity cylinder stocks. This procedure, however, is not beneficial unless these heavier cylinder stocks can be finished to the normal 150 viscosity bright stock. If the viscosity of the heavier cylinder stock is not reduced in finishing there would be no net gain in neutral equivalent because all of the intermediate distillate would be required to adjust the bright stock viscosity. This distillation step would not be without complication because some type of solvent dewaxing process probably would be required to dewax the intermediate distillates.

Presumably two methods are available for producing 150 viscosity bright stock from higher viscosity cylinder stocks without resorting to thermal decomposition. These methods are: (1) Vacuum distillation (or its equivalent) where an overhead cylinder stock and very high viscosity fuel oil bottoms would be obtained, and (2) propane deresining where 150 viscosity residual stock would be produced before or after dewaxing the high viscosity cylinder stock. In so far as it is known no distillation process has been developed which is entirely satisfactory from yield and economic viewpoints when reducing Pennsylvania residuum to less than 1 per cent of the crude. Propane deresining, on the other hand (especially if used in conjunction with propane dewaxing), has been shown to be satisfactory from both yield and economic viewpoints.

The propane dewaxing and deresining plant of the Kendall Refining Co. was originally operated on a cylinder stock having a viscosity of about 165 S.S.U. at 210° F., with the removal of about 3 to 5 per cent of very heavy resins having a viscosity of 3,000 to 4,000 S.S.U. at 210° F. Removal of this quantity of very viscous material (about 0.5 to 0.9 per cent based on crude) increases the equivalent neutral much more than the same amount, and has a rather surprising effect on the surplus bright stock.

In the first place, distillation of the crude to 165 viscosity instead of the normal 145 viscosity gives an intermediate waxy distillate cut amounting to 2.2 per cent of the crude. Approximately 85 per cent of this fraction is then obtained as zero pour test distillate after propane dewaxing, with a viscosity of 53 S.S.U. at 210° F. This represents an increase of dewaxed distillate yield of 1.87 per cent based on crude which is about 30 per cent of the usual neutral production. Since this oil is slightly heavier than neutral, it cannot all be considered as a net gain, but it can be assumed to be a blend of 77 per cent of 180 viscosity neutral and 23 per cent of 150 viscosity bright stock, so that its neutral content is 1.43 per cent of the crude and its bright stock content is 0.44 per cent of crude. By distillation to 165 viscosity at 210° F., the cylinder stock was reduced from 19.5 to 17.3 per cent of crude and the actual bright stock was reduced from 16 per cent to 13.7 per cent of crude by the combined effects of distillation and deresining. This method of processing, which was the one originally adopted by the Kendall Refining Co., increased the equivalent 180 viscosity neutral by 25 per cent and decreased the total bright stock by 12 per cent below that which would have been obtained by propane dewaxing alone without deresining. Actually the yield of total bright stock, including that in the intermediate distillate, remained almost constant as compared with conventional processing, because the increased dewaxing yield by propane dewaxing compensates for the lesser amount of cylinder stock made as well as for the removal of the very viscous resin fraction.

Second half of article. First appeared starting on page 174 issue of October 27, 1938

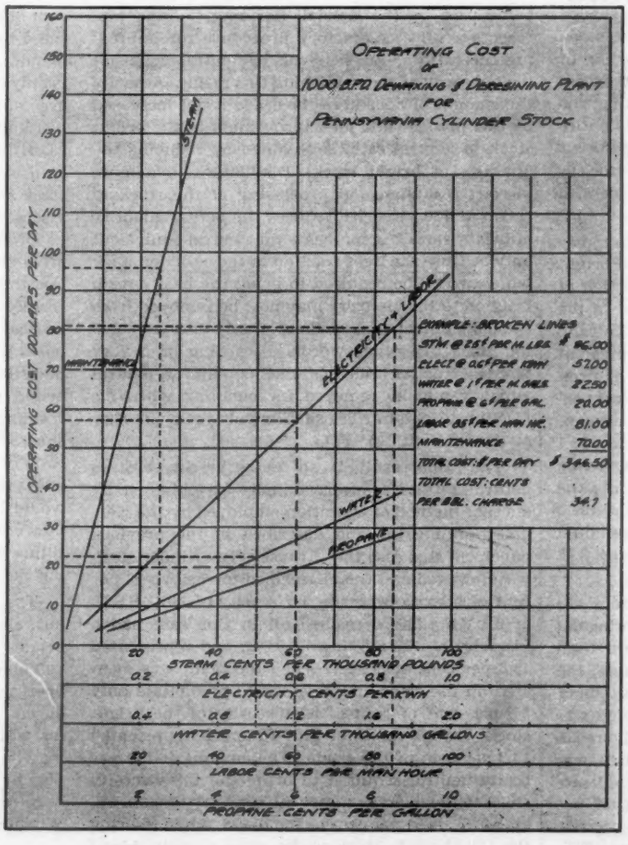
OPERATING COST OF 1000 B.P.D. DEWAXING & DERESINING PLANT FOR PENNSYLVANIA CYLINDER STOCK
OPERATING COST DOLLARS PER DAY
STEAM
ELECTRICITY & LABOR
MAINTENANCE
WATER
PROPANE
EXAMPLE: BROKEN LINES
STM @ 25¢ PER M. LBS. $ 96.00
ELECT @ 0.6¢ PER KWH 57.00
WATER @ 1¢ PER M. GALS. 32.50
PROPANE @ 6¢ PER GAL. 20.00
LABOR 8¢ PER MAN HR. 81.00
MAINTENANCE 70.00
TOTAL COST $ PER DAY $ 346.50
TOTAL COST: CENTS PER BBL. CHARGE 34.7
STEAM CENTS PER THOUSAND POUNDS
ELECTRICITY CENTS PER KWH
WATER CENTS PER THOUSAND GALLONS
LABOR CENTS PER MAN HOUR
PROPANE CENTS PER GALLON

Figure 6

Instead of a surplus bright stock of 80 per cent or more by conventional processing or by propane dewaxing without deresining, the surplus bright stock by this process is only 61 per cent.

Although the above operation represents a significant improvement in the ratio of neutral to bright stock, the method has been carried even further in more recent plant operations. The distillation step has been operated to produce 15.4 per cent of a 190 viscosity cylinder stock and 4.1 per cent of intermediate distillate which has a viscosity of 58 S.S.U. at 210° F. after dewaxing to zero pour test with a yield of about 85 per cent. This distillate may be considered as 67 per cent neutral and 33 per cent of 150 viscosity bright stock, and the net increase in neutral yield is therefore 2.4 per cent of the crude or 40 per cent of the neutral from operation without deresining. At the same time the actual bright stock has been reduced from 16 per cent without deresining to 11.7 per cent of the crude and the total bright stock equivalent is 12.8 per cent of the crude. The neutral equivalent is thus increased by 40 per cent and the bright stock is reduced by 19 per cent from that obtained without deresining or by only 11 per cent from that obtained by previous processing methods. The surplus bright stock has been reduced from about 12 per cent to slightly more than 8 per cent of crude.

These results have been obtained

when operating the propane dewaxing and deresining plant on the residual stocks of the above viscosities. No difficulties have been encountered in dewaxing and deresining any of the cylinder stocks which have been used, covering the range from 150 viscosity to 190 viscosity at 210° F. and pour tests from 0° F. to +20° F. Obviously, the yield of dewaxed and deresined oil decreases as the viscosity of the charge increases, because the high viscosity fraction must be increased to maintain a constant product viscosity of 150 S.S.U. at 210° F.

A comparison of the results of these methods of operation with those obtained by conventional processes is presented in Table 1. In all cases the actual 180 viscosity neutral remains constant at 6 per cent of the crude, but as the viscosity of the cylinder stock is increased from 145 to 190 the amount of blended motor oil which can be produced from the crude increases from 9.2 per cent to 12.9 per cent. This increase of 40 per cent in blended motor oil production results from the elimination of only 1.4 per cent of the crude as very viscous material. This represents a net fuel production of only 0.8 per cent of the crude when taking filter losses into consideration.

TABLE 1—EFFECTS OF PROCESSING METHODS ON DISTRIBUTION OF PRODUCTS

	Using conventional methods	Using propane dewaxing	Using propane dewaxing and deresining	
Viscosity at 210° F. of cylinder stock	145	145	165	190
Cylinder stock, per cent of crude	19.5	19.5	17.3	15.4
Zero pour cylinder stock, per cent of crude	15.3	16.6	14.7	13.1
Resins removed, per cent of crude	...	...	0.7	1.4
Filtering loss, per cent of crude	0.8	0.6	0.3	0
Finished 150 viscosity bright stock, per cent of crude	14.5	16.0	13.7	11.7
Zero pour 180 viscosity neutral, per cent of crude	6.0	6.0	6.0	6.0
Intermediate waxy distillate, per cent of crude	...	...	2.2	4.1
Intermediate zero pour distillate, per cent of crude	...	...	1.9	3.5
180 neutral equivalent of intermediate distillate, per cent of crude	...	...	1.4	2.4
150 vis. bright stock equiv. of intermediate dist., per cent of crude	...	...	0.5	1.1
Total 180 neutral or equivalent, per cent of crude	6.0	6.0	7.4	8.4
Total 150 bright stock or equivalent, per cent of crude	14.5	16.0	14.1	12.8
Total lube made, per cent of crude	20.5	22.0	21.6	21.2
Bright stock blended with motor oils, per cent of crude	3.2	3.2	4.0	4.5
Total blended motor oils, per cent of crude	9.2	9.2	11.5	12.9
Bright stock-neutral ratio	2.42	2.67	1.90	1.53
Surplus bright stock, per cent of crude	11.3	12.8	10.1	8.3

TABLE 2—YIELDS OBTAINED WITH VARIOUS STOCKS

(Six months totals)

	Cylinder stock (165 vis. at 210° F.) Zero pour 125 vis.	Cylinder stock (165 vis. at 210° F.) Zero pour 150 vis.	Cylinder stock (165 vis. at 210° F.) +20° F. pour 150 vis.	Heavy neutral zero hr.	Light neutral zero hr.
Stocks charged, bbls.	12,676	45,837	59,872	14,864	37,727
Dewaxed oil, bbls.	10,717	39,180	54,218	12,558	31,089
Per cent	84.6	85.5	90.5	84.5	82.4
Dewaxed and deresined oil, bbls.	8,797	36,647	51,152	.....	.....
Per cent	69.4	80.0	85.4	.....	.....
Petrolatum or wax, bbls.	1,959	6,657	5,654	2,306	6,638
Per cent	15.4	14.5	9.5	15.5	17.6
Resins, bbls.	1,920	2,533	3,066	.....	.....
Per cent	15.2	5.5	5.1	.....	.....

TABLE 3—OPERATING COST OF PROPANE PROCESSING

	Dewaxing	Deresining	Dewaxing and deresining
Charge capacity, bbls. per day	1,000	850	1,000
	Operating cost: dollars per day		
Steam at 25 cents per 1,000 pounds	$64.00	$81.50	$96.00
Electricity at 6 cents per kilowatt-hour	62.00	2.50	57.00
Water at 1 cent per 1,000 gallons	20.00	14.50	22.50
Propane at 6 cents per gallon	14.00	15.50	20.00
Labor at 85 cents per man-hour	81.00	41.50	81.00
Maintenance at 3 per cent	60.00	20.00	70.00
Total	$301.00	$175.50	$346.50
Cost, cents per barrel charge	30.1	20.6	34.7
Cost, cents per barrel cylinder stock	30.1	17.6	34.7

Effect Shown

The effect of propane dewaxing and deresining on the distribution of products from the lubricating fraction of Pennsylvania crude is shown even more strikingly in Figure 3. Although the actual neutral remains constant, the equivalent neutral, above the dotted line, gradually increases from zero to 2.4 per cent as the viscosity of the cylinder stock increases from 145 to 190 S.S.U. at 210° F. The actual bright stock is decreased from 16 per cent to 11.7 per cent by the removal of intermediate distillate and heavy fractions, while the equivalent bright stock decreases from 16 to 12.8 per cent.

In order to show the net result of this method of processing, the total amount of blended motor oils which can be produced is represented by the distance above the dividing line between the shaded and unshaded portions. The excess bright stock is indicated by the height of the shaded portion of the figure. This shows quite clearly that excess bright stock decreases much more rapidly than the loss to heavy products increases. Over this entire range the net increase in fuel is only 0.8 per cent of crude, but the decrease in excess bright stock is 4.5 per cent of crude and the increase in blended motor oil is 3.7 per cent of crude.

These results may be presented still differently as in Figure 4, in which the ratio of finished bright stock to finished neutral is shown as a function of the viscosity of the residual stock charged to the propane dewaxing and deresining plant. The ratio as shown here is based on including the equivalent amount of bright stock and neutral which is present in the intermediate distillates. In the conventional processing of Bradford crude the ratio of bright stock to neutral was approximately 2.5 to 1 as shown in Table 1, while with propane dewaxing without deresining the ratio was 2.7 to 1. As the viscosity of the residual stock increased, the ratio decreased until it reached 1.5 to 1 at the maximum viscosity thus far used commercially of 190 S.S.U. at 210° F.

One point, which may not be clear from the above discussion, is that the total lubricating oil yield is actually higher by this procedure than with the conventional process. For example, the total lubricating oil previously made was about 20.5 per cent of crude, 14.5 per cent of which was bright stock. Even when the viscosity of the residuum charged to the propane dewaxing plant was 190 S.S.U. at 210° F., the total lubricating oil produced was 21.2 per cent or an increase of 0.7 per cent in spite of discarding a portion of the crude (about 1.4 per cent) as very viscous resins. This increase is of course due to the higher dewaxing yields and lower decolorizing loss, which more than offset the 1.4 per cent of the crude discarded. The net result of propane dewaxing and propane deresining is thus to increase the yield and decrease the average viscosity of the oils produced.

Not Only Way

Although the method outlined above is now being used by the Kendall Refining Co. and represents a very satisfactory procedure for improving the ratio of bright stock to neutral, it is not the only way of accomplishing this result. Actually the amount of neutral in the crude is not increased by this process, and all improvement in the bright stock to neutral ratio is obtained by reducing the quantity of bright stock. Distillation to a more viscous residuum and processing of the stock to finish at 150 viscosity reduces the actual quantity of bright stock but increases the neutral equivalent only because the light fraction of the cylinder stock which would be required to bring the heavy resin fraction to 150 viscosity may now be removed from the bright stock and used separately or as a blending stock. In other words, discarding of a very viscous fraction releases the amount of neutral which would be required for blending with this fraction to obtain the usual bright stock viscosity of 150 S.S.U. at 210° F.

The same result, in so far as bright stock to neutral ratio is concerned, may be obtained by another method of operation employed by the Kendall Refining Co. and described in the previous paper. In this case the 157 viscosity cylinder stock was dewaxed and then deresined to remove 13 per cent of heavy oil having a viscosity of 1,151 S.S.U. at 210° F. The deresined oil in this case had a viscosity of 117 S.S.U. at 210° F. and represented 13.5 per cent of crude. When the plant was operated on the same charge stock to precipitate only 3.5 per cent of resins, the viscosity of the bright stock was 148 S.S.U. at 210° F. and it represented 15.3 per cent of the crude. The amount of 180 viscosity neutral required to bring the 148 viscosity stock to the average motor oil viscosity of 60 S.S.U. at 210° F. is 64 per cent of the blend, while to bring the 117 viscosity stock to the same viscosity blend the neutral required is only 58 per cent. The 6 per cent of neutral available in the crude could therefore be used to blend with 4.4 per cent of 117 viscosity bright stock instead of only 3.4 per cent in the case of 148 viscosity bright stock. By this method, therefore, the blended motor oil is increased from 9.4 per cent to 10.4 per cent by the elimination of an additional 1.8 per cent of the crude processed in this manner. Since only 6 per cent of cylinder stock would be required to produce the 4.4 per cent of low viscosity bright stock for blending, the average amount of additional resins is only 0.6 per cent. The same general result is thus accomplished by this method of operation as when distillation to heavier cylinder stock is resorted to, although in the present case a portion of the gain is a result of reducing the quantity of bright stock and another portion is the result of the lower viscosity of the bright stock produced.

Of course it would not be possible to process all of the residual stock by this latter process, unless the excess 117 viscosity bright stock could be readily marketed. It is possible, however, to so process the bright stock used for blending purposes in the refinery, and to process surplus cylinder stock to produce a marketable 150 viscosity bright stock while still taking advantage of deresining to reduce filtration costs on the latter stock. The net effect on bright stock to neutral ratio of producing a portion ot the bright stock at low viscosity and a portion at normal viscosity would be essentially the same as for the method now employed by the Kendall Refining Co. of distilling a portion of the cylinder stock and processing the heavier residuum.

The above indicated processing methods might not always prove economically desirable when bright stock is in great demand, unless reasonably valuable by-products could be obtained from the operations when a large amount of resins is produced. Plant operations have shown that the resins which have been produced by these processes may be converted to high viscosity specialty products by relatively minor changes which have now been made in the deresining portion of the plant. When the very high viscosity products are market-

(Continued on Page 244)

QUESTIONS ON TECHNOLOGY

By Charles K. Francis, Ph. D., Technical Editor

Overall Percentage Refining Loss In Modern Complete Refineries

What overall percentage loss between crude receipts and finished products shipments should be expected in a large complete refinery including cracking and lubricating oil operations?—S. A. B.

Petroleum refiners report total losses ranging from nothing to 12 per cent, some part of which may be actual, but very often is a false figure due to the accounting methods and failure to use accurate equivalents. The general practice is to use liquid volumes for indicating the quantities of crude oil and petroleum products, but gas is recorded as cubic feet and coke and wax by weight, in pounds and tons. It is difficult to determine just what should be used as the correct conversion factor for each of these when changing the original data to a volume basis.

The chief sources of loss in petroleum refining are evaporation, gas, emulsions, sludges, leaks and spills, if all measurements have been correct. The care with which these items are controlled will be reflected in the final statement of loss during the refining operations. Spills and leaks may not necessarily mean actual loss of the oil, for it may be recovered if the drainage system, including the separators, is adequate for recovery.

There are several schemes for eliminating evaporation losses from tanks, which may run to a high percentage when volatile oil is stored in tanks not properly protected. Losses from tanks have been as high as 10 per cent and 3 to 7 per cent are common. Such losses may be considerably reduced and possibly eliminated by the use of reflecting paints, breathing devices, water sprays, insulation, floating roofs, pressure tanks, and water covered roofs. Breathing equipment is a part of the gas collecting system for the gas recovery plant.

The gas evolved from a barrel of oil during the several steps in the refining operation varies from about 150 to 1,500 feet, the greatest volume being formed from the very high gravity crude oils in the primary distillation unit and during cracking and polymerization. This gas seldom has a heating value below 1,000 B.t.u. per foot and a part of it may have a much higher value. Gas of 1,350 to 1,500 B.t.u. is frequently made. The modern refinery has all units gastight, collecting the gas from the tanks, the condensing equipment, treating system, and wherever gas may be had, to recover propane, butane, and gasoline. The dry gas from the gas recovery plant is usually consumed as fuel. The liquid products are measured and shown as manufactured products, but the gas used for fuel must be converted from a gas volume of cubic feet to a liquid volume of barrels or gallons before determining the percentage. There is no standard method for doing this. Some refiners convert on the broad statement that 18,000 feet of gas is the equivalent of 3 bbls. of oil or 6,000 feet represents 1 bbl.; others reduce this last figure to 5,600 feet. A more accurate procedure is to have sufficient analyses to express the gas and liquids in terms of B.t.u.; although an uncertainty must remain as to just what oil the gas represents.

A barrel of oil of 10 gravity may be represented as B.t.u.'s in gas form by 6,484,842 or 5,895 feet of 1,100 B.t.u. gas, but 30-gravity oil has a B.t.u. value of 5,950,896, which is the equivalent of 5,410 feet of the same gas. The volume of the same gravity oil decreases as the heating value of the gas rises on a conversion basis.

When sludges and emulsions are burned as fuel similar reasoning applies. The most accurate relationships between these and the barrel of oil processes are those that are ascertained at very frequent intervals. Many refineries have facilities for converting these waste materials, including sediments, into useful products or for burning them as fuel and thus recovering a large part of the percentage which is frequently a loss.

This discussion presupposes a 100 per cent oil being received at the refinery, with adjustment being made for any water or sediment contained in the oil. Another factor which is not always taken into consideration is adjustment of the crude oil volume and all products to the standard temperature of 60° F. Some operators make no correction of crude oil volumes, others use a percentage figure to cover a definite spread, but many refiners make use of the coefficients of expansion as arranged in the standard tables of the U. S. Bureau of Standards.

This brief reference to the several conditions that have to be correctly adjusted is intended to suggest what must be accomplished in the modern refinery if the loss is to be kept at the minimum. The authorities agree that a final refining loss of 1.5 to 3 per cent indicates good operation for a complete refinery.

Average Yield of Products From Petroleum In the United States

Would you kindly furnish the information showing the average percentage yield of products now obtained from the crude oil of the United States?—R. C. M.

The latest figures available showing the yield of products from crude petroleum in the refineries of the country are those by White, Hopkins, and Breakey in the Minerals Yearbook for 1938. These are preliminary figures computed on the total crude oil run to stills during the year 1937.

YIELDS OF REFINED PRODUCTS IN THE U. S.

Products—	Per cent	Gals./bbl.
Finished products:		
Gasoline	43.9	18.438
Kerosene	5.5	2.310
Gas oil and distillate fuels	12.4	5.208
Residual fuels	26.2	11.004
Lubricants	3.0	1.260
Wax	0.1	.042
Coke	0.5	.210
Asphalt	2.0	.840
Road oil	.7	.294
Still gas	5.2	2.184
Other	0.2	.084
Unfinished products:		
Other	*0.5	.210
Shortage	0.8	.336

*Negative percentage; represents excess percentage rerun over percentage produced.

The quantity reported under shortage is an accounting figure, indicating the difference between the volume of oil reported run to stills and the reports of yields at the refineries.

Reefrence: Minerals Yearbook 1938, U. S. Bureau of Mines, page 862.

Kinsel Process For Recovering Lead From Spent Plumbite Solution

If possible to do so will you kindly give me the essential facts covering a Kinsel process for recovering lead from refinery waste materials?—P. D. N.

The Kinsel process was described in The Oil and Gas Journal by L. M. Fanning in October 1925. The following is from this article.

The lead sulphide and spent caustic soda solution drawn from the agitators is run to a settling tank where by means of a steam coil it is warmed up and then allowed to settle—this warming greatly facilitates the separation of the lead sulphide and caustic. The clear settled caustic solution is drawn off to be made further use of and the lead sulphide is pumped to the filter. Here it is filtered as dry as possible (about 30 per cent moisture content) and then discharged into a tank containing a necessary amount of diluted sludge acid for the conversion of the sulphide to the sulphate.

The acid used is the sludge acid from previous gasoline treatment which has been diluted with water to 35-40 degrees Baume and allowed to stand for separation of the tar present.

After complete conversion in this tank, the lead sulphate is pumped to a washing tank where it is washed to an acid content of about 0.5 per cent. The lead sulphate is now ready to be discharged to storage or direct to the solution tanks where it is mixed with caustic soda solution to give fresh "Doctor" solution.

The process not only totally recovers the lead sulphide, it also recovers 75 to 80 per cent of the caustic soda used in making up the "Doctor" solution, and the gasoline which may be drawn from the agitator along with the lead sulphide.

As the lead sulphide is totally recovered into sodium plumbite, it naturally assumes the prevailing market value of lead oxide.

Reference: L. M. Fanning, The Oil and Gas Journal, October 1, 1925, page 352.
U. S. Patent, A. Kinsel, No. 1,525,301.

CHEMICALS FOR THE PETROLEUM INDUSTRY

Ammonium Chloride

Use—Manufacture of candles.

Form—Grayish lumps, small crystals or white granules.

Formula—NH_4Cl.

Molecular weight—53.5.

Specific gravity—1.52.

Melting point—Volatilizes. (May be melted under about 957 pounds pressure—1,022° F.)

Solubility—Water, glycerol, 29 per cent in cold and 77 per cent in hot water.

LIMITATIONS

Impurities, total, per cent	1.00
Residue, after ignition, max., per cent	0.01
Free acid, per cent	none
Sulfates	none

PROBLEMS FROM READERS

Edited by L. G. E. Bignell

Use For Hollow Ball Valves

I have some pumping problems and it has been suggested that I try hollow steel balls in both standing and traveling valves. Can you tell me something about the use of such balls for this purpose?—E. E. I.

The suitability of ball valves for certain conditions of pumping is well understood. Pump designers also recognize that ball valves have at least two definite disadvantages.

First—For a given valve chamber ball valves furnish the least area for the passage of the fluid, of all the ordinary types.

Second—The weight of the balls, except for the small sizes, is so great that the seats are soon pounded to pieces.

In order to get the required area through the valve seats the designer had to resort to larger size balls. This meant greater weight, augmenting difficulty No. 2.

Naturally the answer was hollow balls. But the making of a satisfactory hollow ball was quite a manufacturing problem. At first they were cast with but limited success. It was almost impossible to cast a ball that was sufficiently well balanced. Also the openings for the cores had to be closed. This was usually done with screwed plugs. The plugs oftentimes leaked and came loose.

The next step in hollow ball manufacture was to take sheet metal of the proper thickness and form the sheets into hemispheres. These were machined so that when two hemispheres were put together a lock joint was produced as the two halves of the ball were rolled one on to the other. After the rolling process, the joint was welded. This made a well-balanced ball, but in service the continued hammering of the ball on its seat finally broke the weld.

With this construction, the welding extended only part way through the wall and the unwelded portion on the inside virtually amounted to a crack in the inside wall and any hollow ball with a surface crack either inside or outside is doomed to failure.

With considerable experience along the above lines National Transit Pump & Machine Co. several years ago commenced the manufacture of hollow balls with the welding of the two hemispheres carried clear through to the inside wall.

In order to insure a perfectly homogeneous, well-worked material devoid of grain, as far as possible, the hemispheres were formed from bar stock. After forming and sizing, the two halves were fused together electrically requiring, incidentally, for the larger sizes, considerable current.

This process, worked out with great care, is now in use in the manufacture of hollow balls.

After fusing, the balls are ground and polished in the regular ball grinding machines.

Guarantee as to spherical tolerance on balls 3 inches in diameter and over is from .0002 to .0005 although 90 per cent of these come within .0001.

For truthfulness to normal diameter for 3 inches and above a tolerance of plus or minus .015 from the normal size is preferred.

Testing for balance is effected by floating the balls on a bath of mercury. The ball is allowed to come to rest. This means that the heaviest side is down and the lightest point is uppermost. The ball is then turned on the bath through 90 degrees. This brings the heavy and light axis horizontal. Then when the ball is released it has to swing back to its position of equilibrium very slowly or else it does not pass the test. If it swings back rapidly and dances back and forth in coming to rest, it is not sufficiently well balanced and is discarded.

Estimated Recovery Compared With Actual Production

Do you know of any instance where an oil sand has been depleted and a complete record kept of the volume of oil produced? Also do you know of any prediction having been made upon the estimated recovery of oil from such a depleted field which would serve as a check upon the volume of oil recovered as compared with the estimated recovery?—R. S. J.

There are not many instances in which oil fields have been depleted and complete recovery records kept as well as estimates of oil to be recovered made in advance. The very old fields which may be depleted did not have records available of the volume of oil produced. Younger fields upon which estimates of recovery have been made are still producing but there is one instance recently noted in which a sand in the Cotton Valley field, Louisiana, is practically depleted and upon which an estimate of oil to be recovered was made eight years ago. The estimated and actual recovery check within 1 per cent which is practically perfect.

The incident referred to is covered by a press release from the Bureau of Mines recently and recites the case of a verification of estimate of recovery of oil from the Blossom sand in the Cotton Valley field, Webster Parish, Louisiana. In 1931 the bureau issued Technical Paper 504, an engineering report upon the Cotton Valley field prepared by John S. Ross, then petroleum engineer for the Bureau of Mines. The field data were gathered in May, 1930, and using logarithmic production decline curves, Ross estimated "that when the average well in the Blossom sand reached a production of 5 bbls. per day or 450 bbls. per quarter (three months), the future production would be 3,500,000 bbls., or a total recovery of approximately 14,600,000 bbls. for the field."

At the end of 1937 the oil produced from the shallow sands of the Cotton Valley field was 14,911,015 bbls. From the total shallow sand production approximately 325,000 bbls. was produced from the shallow "Trinity" sand (depleted at the time the report was made) and this volume should be deducted from the total production reported and this leaves a balance from the Blossom sand of 14,586,000 bbls., or within 14,000 bbls. of 1 per cent of the estimate prepared by Mr. Ross. Some oil will still be recovered from this sand but the total additional amount will not be much and it therefore appears that the estimate made eight years ago when engineering knowledge regarding the behavior of reservoir fluids was not as advanced as it is today was within a very small percentage of the actual total recovery.

Connections Between Flow and Stock Tanks

I have a small lease and am handling my oil and gas through a flow tank and passing it from the flow tank to the stock tanks which are connected with the pipe line. Even in relatively cold weather I have noted some gas coming off of the stock tanks and wonder where it can come from and what method can be used to stop it?—A. E. I.

From the conditions outlined above it would seem that your well or wells are connected into the flow tank and deliver to it all the well's production, that is, all oil, water and gas. It would also appear there is some pressure on the flow tank causing gas to pass over with the oil. This gas is actually entrapped or entrained in the oil and when it reaches the storage tanks it has a chance to escape because being lighter than any other product in the tank it comes to the surface.

This practice can actually lower the gravity of the oil in the stock tanks that will be delivered to the pipe lines, and it will be found an appreciable increase in gravity can be secured if this gas is trapped off in the flow tank and not permitted to pass over with the oil to the stock tanks.

This can be done by a very simple method and the use of a few pipe fittings to form a seal in the flow tank through which the gas cannot pass.

If the tank can be opened and entered it is best to put the trap on the inside. To do this a short nipple, say one 4 inches long and of the same size as the outlet flange, is screwed into the inside half of this flange. Then use an elbow and a piece of pipe turned down to form the seal.

If the long leg of this trap, that is the piece of pipe turned down, is cut to a length that will have 3 inches of length for each ounce of pressure placed upon the flow tank, the gas cannot pass out with the oil.

Assuming that your flow tank is working under a pressure of six ounces above atmosphere, the long piece of pipe turned down in the tank to form the seal should be about 18 inches long. This will form a column of oil that in effect has the weight equal to the pressure placed on the tank, so the gas cannot force itself down and out of the tank with the oil, and must pass away from the flow tank through other suitable passages provided for its escape.

If it is not possible to get inside the flow tank to install the device as described above, it is possible to form a seal outside of the tank by using a short nipple screwed into the outside of the outlet flange, and into that nipple screw an elbow and turn it upward and screw into this upturned elbow a piece of pipe cut to the required length as described above. Then lead the oil back down to the level of the outlet flange by using another elbow and nipple with a third elbow screwed into the nipple and turned down and a second piece of pipe screwed into it and on the end of that pipe is placed a fourth nipple turned in the direction of flow from the flow tank to the stock tanks.

This is in effect an inverted U and has the effect of raising the oil level within the tank to form a seal equal to the pressure in the tank.

Type G-SD

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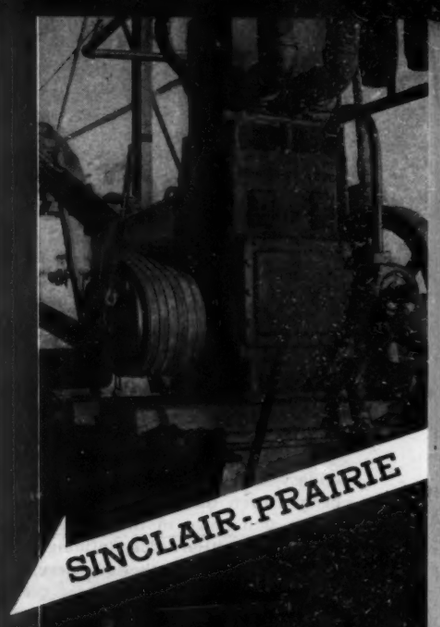

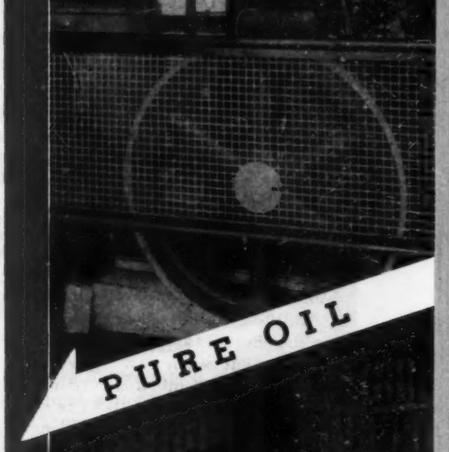

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Mid-Continent Refinery Crude Runs Remain Unchanged in November

During November Mid-Continent refinery crude runs will remain practically unchanged even though three important refineries will be shut down in the month. These include the plant of the Barnsdall Refining Corp. at Barnsdall, which last month had a daily throughput of 2,000 bbls.; the Cities Service Oil Co. refinery at Okmulgee, which had a daily schedule in October of 1,050 bbls. per day, and the Cosco Oil Co. at Wynnewood, which had a daily crude throughput in October of 1,300 bbls.

Total estimated daily average crude runs in the Mid-Continent for November will be down 7,290 bbls. when compared with October. This month they are estimated at 524,035 bbls., compared with 531,325 bbls. in October, and compared with 548,015 bbls. in November a year ago.

West and Southwest Texas

With interior plants holding runs down, there were slight changes in crude runs in West Texas, the total being 78,075 bbls. in November and 77,625 bbls. for October. Cosden Oil Co. at Big Spring, Tex., increased its daily run from 8,500 bbls. to 9,700 bbls., an increase of 1,200 bbls. but was more than offset by a decrease of 1,400 bbls. in the daily runs of the Gulf Oil Corp. at Sweetwater. Phillips at Borger remains unchanged at 25,000 bbls. daily Southwest Texas shows very little change from last month.

East Texas

The Cascade Refining Co.'s plant at Reed Switch, Tex., was shut down temporarily which reduced crude runs in that area 2,000 bbls. per day. Other reductions in this area include Sinclair Refining Co. at Camp Switch, from 2,700 bbls. to 1,800 bbls.; Clay Refining Co. at Arp, from 2,100 bbls. to 2,000 bbls., and the Magnolia Petroleum Co. at Corsicana, from 4,650 bbls. to 4,600 bbls. Refineries increasing their daily crude runs more than offset the total reduction. Increased runs are reported as: Lacy Refining Co. at Kilgore, from 1,800 bbls. to 2,500 bbls.; McMurrey Petroleum Co. at Tyler, from 2,600 bbls. to 4,500 bbls.; Premier Oil Refining Co. of Texas at Greggton, from 2,700 bbls. to 3,000 bbls.; Southport Petroleum Co. at Kilgore, from 2,600 to 3,000 bbls.; Texas Oil Products Co. at Gladewater, from 1,500 bbls. to 1,700 bbls., and the Utah Refining Co. at Kilgore, from 1,300 bbls. to 1,800 bbls. The total estimated crude run during November is 55,875 bbls., an increase of 1,050 bbls. daily over October. The Beacon Oil & Refining Co. at Henderson has resumed operations this month with a daily run of 100 bbls.

Mid-Continent Crude Runs
Average Daily (Barrels)

(Advance estimate compiled by The Oil and Gas Journal)

	1936	1937	1938
January	501,600	531,535	529,710
February	519,960	541,790	507,985
March	478,760	533,875	491,935
April	506,775	558,385	532,120
May	513,510	572,855	527,315
June	527,225	593,625	540,005
July	539,370	605,640	557,520
August	557,650	624,475	554,810
September	553,215	625,485	555,695
October	536,330	619,210	531,325
November	548,015	592,170	524,035
December	535,500	544,040	

Operations by Refinery Districts

Daily crude runs

	Nov.	Oct.	Decr.
Arkansas	25,325	26,025	700
East Texas	55,875	54,825	*1,050
Kansas	126,850	127,150	300
N. Central Texas	31,460	34,450	2,990
North Louisiana	45,000	46,000	1,000
Oklahoma	146,000	149,950	3,950
Southwest Texas	15,450	15,300	*150
W. Texas Panhandle	78,075	77,625	*450
Total	524,035	531,325	7,290

*Increase.

North Central Texas

In the North Central Texas area Continental Oil Co. at Wichita Falls reduced its daily runs from 4,180 bbls. to 3,200 bbls., and the Gulf Oil Corp. at Fort Worth reduced its runs from 7,000 bbls. to 5,600 bbls., bringing the estimated runs for the month of November down 2,990 bbls. All other refinery runs in this area remained unchanged.

North Louisiana and Arkansas

No important changes were anticipated in the North Louisiana and Arkansas areas. In North Louisiana crude runs are down 1,000 bbls., which is accounted for by the reduction of the East Texas Refining Co.'s plant at Sandra. All other crude runs remain unchanged. Arkansas throughput is slightly lower in November than last month with small reductions at several refineries. Lion Oil Refining Co. at El Dorado remains unchanged at 13,225 bbls. daily.

Kansas

Kansas continues to witness a high production of oil. However, this has not encouraged higher refinery operations due to the low refined oil prices. The prolonged condition has influenced the Shell Petroleum Corp. to dismantle its Arkansas City refinery.

Total Kansas runs for November will be 126,850 bbls. daily compared with 127,150 bbls. in October.

Estimated Daily Average Mid-Continent Refinery Crude Runs for November

OKLAHOMA

Company and location—	Daily capacity	Av. dly. runs Nov.	Av. dly. runs Oct.
Anderson-Prichard Ref. Corp., Cyril	7,500	6,500	6,500
Barnsdall Ref. Corp., Barnsdall	5,000	(*)	2,000
Bell Oil & Gas Co., Grandfield	5,000	3,000	3,000
Black Gold Ref. Co., Oklahoma City	2,500	(*)	(*)
Champlin Ref. Co., Enid	16,000	15,000	15,000
Cities Service Oil Co., Okmulgee	4,000	(*)	1,050
Cities Service Oil Co., Ponca City	12,000	9,600	9,300
Continental Oil Co., Ponca City	28,000	19,500	19,500
Cosco Oil Co., Wynnewood	2,500	(*)	1,300
Cushing Ref. & Gasoline Co., Blackwell	1,700	(*)	(*)
Cushing Ref. & Gasoline Co., Cushing	4,200	4,000	4,000
Deep Rock Oil Corp., Cushing	10,000	9,000	9,000
Eason Oil Co., Enid	3,000	(*)	(*)
Globe Oil & Ref. Co., Blackwell	8,000	(*)	(*)
Johnson Oil Ref. Co., Cleveland	6,000	3,500	3,500
Knox Ref. Co., Covington	300	100	100
Mid-Continent Pet. Corp., West Tulsa	35,000	20,000	20,000
Ohio Oil Co., Bristow	5,000	2,500	2,500
Omar Ref. Co., Garber	5,000	2,000	2,000
Phillips Pet. Co., Okmulgee	6,500	6,000	6,000
Peppers Gasoline Co., Oklahoma City	500	400	400
Pure Oil Co., Muskogee	9,000	6,000	6,000
Rock Island Ref. Co., Beckett	6,500	5,000	5,000
Sinclair Ref. Co., Sand Springs	6,000	4,000	4,000
Sun Oil Co., Yale	5,000	2,000	2,000
Sunray Oil Co., Allen	7,000	3,600	3,800
Texas Co., West Tulsa	16,000	10,000	10,000
Tide Water Oil Co., Drumright	12,000	11,000	11,000
Wilcox Oil & Gas Co., Bristow	6,000	3,300	3,000
Total	235,700	146,000	149,950

*Shut down.

NORTH CENTRAL TEXAS

Company and location—	Daily capacity	Av. dly. runs Nov.	Av. dly. runs Oct.
Baird Ref. Co., Baird	1,500	1,200	1,300
Bryson Pipe Line & Ref. Co., Bryson	2,000	1,500	1,500
Coleman Ref. Co., Coleman	1,000	500	400
Continental Oil Co., Wichita Falls	6,000	3,200	4,180
Denver Prod. & Ref. Co., Gainesville	3,000	1,000	1,000
Exchange Pet. Corp., Albany	800	(*)	(*)
Falls Ref. Co., Wichita Falls	2,500	500	500
Gratex Ref. & Fuel Oil Co., Graham	300	285	285
Gulf Oil Corp., Fort Worth	8,000	5,600	7,000
Hightower Oil & Ref. Corp. Brownwood	750	200	200
Jacksboro Ref. Co., Jacksboro	400	175	150
La Salle Pet. Co., Burkburnett	3,000	1,000	1,000
Magnolia Pet. Co., Fort Worth	7,500	6,000	6,330
Midway Ref. Co., Goldsboro	300	100	100
North Texas Ref. Co., Gainesville	600	300	300
Ohio Oil Co., Fort Worth	5,000	3,900	3,900
Olney Oil & Ref. Co., North Olney	3,500	1,000	1,000
Panhandle Ref. Co., Wichita Falls	4,200	2,500	2,800
Panhandle Ref. Co., Luederes	1,500	900	900
Southland Ref. Co., Olney	500	100	100
Taylor Ref. Co., Taylor	1,000	750	750
Texas Pacific Coal & Oil Co., Caddo	800	600	600
Tucker Oil Co., Burkburnett	250	150	150
Tydal Ref. Co., Gainesville	1,850	(*)	(*)
Waggoner Ref. Co., Vernon	4,000	(*)	(*)
Total	62,600	31,460	34,450

*Shut down.

NORTH LOUISIANA

Company and location—	Daily capacity	Av. dly. runs Nov.	Av. dly. runs Oct.
Arkansas Fuel Oil Co., Bossier City	25,000	19,000	19,000
Atlas Pipe Line Co., Shreveport	12,500	9,000	9,000
Bayou State Oil Corp., Hosston	750	500	500
East Texas Ref. Co., Sandra	7,000	1,000	2,800
Lake-Price Refineries, Inc.	800	500	500
Premier Oil Ref. Co. of Texas, Cotton Valley	3,000	2,500	2,500
Rodessa Oil & Ref. Corp., Cedar Grove	12,000	10,000	10,500
Stanolind Oil & Ref. Co., Superior	5,000	2,500	1,200
Total	62,250	45,000	46,000

ARKANSAS

Company and location—	Daily capacity	Av. dly. runs Nov.	Av. dly. runs Oct.
Berry Asphalt Co., Waterloo	2,000	800	1,000
Henry H. Cross, Smackover	6,000	3,000	3,000

Company and location—	Daily capacity	Av. dly. runs Nov.	Oct.
Lion Oil Ref. Co., El Dorado	17,000	13,225	13,225
Macmillan Pet. Corp., Norphlet	2,500	2,000	2,300
Root Pet. Co., El Dorado	10,000	5,800	6,000
Stephens Ref. Co., Stephens	700	500	500
Total	38,200	25,325	26,025

KANSAS

Company and location—	Daily capacity	Av. dly. runs Nov.	Oct.
Barnsdall Ref. Co., Wichita	5,000	5,000	5,000
Bay Pet. Co., McPherson	4,000	3,700	3,750
Chanute Ref. Co., Chanute	1,000	1,000	1,000
Chase Ref. Co., Chase	800	(*)	(*)
Derby Oil Co., Wichita	8,000	5,500	5,500
El Dorado Ref. Co., Eldorado	5,000	3,500	4,000
Falcon Ref. Co., Inc., Great Bend	1,000	850	850
Globe Oil & Ref. Co., McPherson	13,000	12,500	12,500
Kanotex Ref. Co., Arkansas City	12,000	6,000	5,500
National Ref. Co., Coffeyville	8,000	5,000	5,000
Pet. Products Co., Chanute	1,250	1,000	1,000
Phillips Pet. Co., Kansas City	23,000	17,500	17,500
Roper Pet. Co., Parsons	750	400	400
Shallow Water Ref. Co., Scott City	2,500	1,200	1,250
Sinclair Ref. Co., Coffeyville	12,000	8,000	8,200
Sinclair Ref. Co., Argentine	11,000	8,000	8,000
Skelly Oil Co., Eldorado	23,000	20,000	20,000
Socony-Vacuum Oil Co., Inc., Augusta	20,000	16,500	16,500
Standard Oil Co. (Indiana), Neodesha	7,500	7,400	7,400
United Ref. Co., Russell	1,200	800	800
Vickers Pet. Co., Potwin	4,000	3,000	3,000
Total	164,640	126,850	127,150

*Shut down.

WEST TEXAS AND PANHANDLE

Company and location—	Daily capacity	Av. dly. runs Nov.	Oct.
Aero Gas & Ref. Co., Fort Stockton	350	100	100
Coltex Ref. Co., Colorado	12,500	8,000	8,000
Concho Ref. Co., San Angelo	250	(x)	(*)
Cosden Oil Co., Big Spring	12,500	9,700	8,500
Danciger Refs., Inc., Pampa	6,500	4,800	4,800
Danube Oil Corp., Borger	1,200	800	500
Farmers Ref., The, Lubbock	500	200	200
Gulf Oil Corp., Sweetwater	7,000	5,400	6,800
Howard County Ref. Co., Big Spring	2,000	750	600
Moutray Oil Co., Hawley	1,400	900	600
Onyx Ref. Corp., Hawley	3,000	1,800	1,700
Panhandle Ref. Co., Kings Mill	2,500	1,300	1,500
Payward Fef. Co., Shamrock	600	600	600
Phillips Pet. Co., Borger	35,000	25,000	25,000
Post Refining Co., Rotan	800	675	675
Shamrock Oil & Gas Corp., Sunray	3,000	2,000	2,000
Shamrock Oil & Gas Corp., Lefors	1,600	1,200	1,200
Standard Oil Co. of Texas, El Paso	14,000	7,400	7,400
Stamford Ref. Co., Stamford	450	400	400
Star Light Ref. Co., Ballinger	1,000	150	150
Texas Co., El Paso	2,000	1,300	1,300
Texas Co., Amarillo	6,000	3,000	3,000
Western Ref. Co., Fort Stockton	1,000	100	100
Wickett Pet. Co., Wickett	3,500	2,500	2,500
Total	122,050	78,075	77,625

*Shut down.

SOUTHWEST TEXAS

Company and location—	Daily capacity	Av. dly. runs Nov.	Oct.
Border Oil & Ref. Co., Sullivan City	1,000	450	400
Carle Ref. Co., Inc., San Antonio	1,000	(x)	(*)
Eggleston Oil Products Co., Three Rivers	1,000	1,000	1,000
Humble Oil & Ref. Co., San Antonio	5,000	3,500	3,500
Ina Oil & Ref. Co., Hondo	400	(x)	(*)
Magnolia Pet. Co., Luling	8,000	4,000	4,000
Majestic Ref. Co., Dale	500	400	300
Misko Refineries, Inc., Mirando City	4,500	(x)	(*)
Pettus Oil & Ref. Co., Pettus	1,000	900	900
Phoenix Ref. Co., San Antonio	1,200	700	700
Phoenix Ref. Co., Pettus	900	500	500
Pioneer Oil & Ref. Co., Somerset	2,000	900	900
Rado Ref. & Prod. Co., McAllen	800	500	500
Texas Co., San Antonio	5,000	2,600	2,600
Total	32,300	15,450	15,300

*Shut down.

EAST TEXAS

Company and location—	Daily capacity	Av. dly. runs Nov.	Oct.
Beacon Oil & Ref. Co., Henderson	4,500	100	(*)
Cascade Ref. Co., Reed Switch	2,000	(x)	2,000
Clay Ref. Co., Arp	3,500	2,000	2,100
Danciger Refs., Inc., Longview	6,000	4,000	4,000
East Texas Ref. Co., Longview	6,000	6,000	6,000
Hurricane Pet. Corp., Overton	5,000	2,875	2,875
Hurricane Pet. Corp., Arp	3,300	2,500	2,500
Lacy Ref. Co., Kilgore	3,000	2,500	1,800
Magnolia Pet. Co., Corsicana	5,000	4,600	4,650
McMurrey Pet. Co., Tyler	10,000	4,500	2,600
Paluxy Asphalt Co., Talco	5,000	3,000	3,000
Premier Oil Ref. of Texas, Greggtown	4,000	3,000	2,700
Sinclair Ref. Co., Camp Switch	4,000	1,800	2,700
Solvex Refs., Inc., Gladewater	4,500	(x)	(*)
Southport Pet. Co., Kilgore	4,000	3,000	2,600
Talco Asphalt & Ref. Co., Mt. Pleasant	7,500	4,000	4,000
Texas Co., The, Dallas	16,000	8,500	8,500
Texas Oil Products Co., Gladewater	3,000	1,700	1,500
Tower Ref. Co., Overton	3,500	(x)	(*)
Utah Ref. Co., Kilgore	2,000	1,800	1,300
Total	105,300	55,875	54,825

*Shut down.

Geologic Map of California

A very fine map of California lithographed in six colored sheets on the scale of 1 inch equals 8 miles has been recently published by the Department of Natural Resources, Division of Mines, for the State of California. This map when assembled is 6½ by 7½ feet in size and is made up of six separate maps which contain a vast amount of information about California. Streams and 100-fathom submarine contours are printed in blue, roads and highways in grayish brown, 80 different geologic units in distinguishing colors and patterns, all over an acurate U.S.G.S. base map. Faults and geologic boundaries accurately plotted on base in black; also including index maps to topographic and geologic source data; rainfall map; glacial map; mineral chart and other useful data; chart, "Looking Back in Geologic Time," with condensed account of geologic history. A geomorphic map shows in five colors, surface and submarine topography, names of mountains and valleys, faults and physiographic provinces. Condensed description of the geomorphic provinces of California is also printed on the geomorphic map. This map has taken nine years to prepare with the cooperation of the federal Government, many universities, various geological departments of scientific and commercial institutes, and hundreds of individual authorities on California geology.

The six sheets are sold together for $4 per set and may be obtained from Walter W. Bradley, State Mineralogist, Division of Mines, Ferry Building, San Francisco, Calif.

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FIELD OPERATIONS

Summarizing the Week's Developments

OKLAHOMA—Wilcox sand production was found in Section 21-13-10, Okfuskee County, near a Dutcher sand pool opened earlier this year. A deep test in the old Dilworth area, Kay County, had an oil showing in Wilcox sand after failing to get production in Arbuckle lime and plugging back. A diagonal offset to the discovery well in the new Meridian pool, Logan County, found saturation in Wilcox sand and was near completion.

KANSAS—Wildcat pool openers were completed in Section 35-15-14w, Russell County, and Section 9-19-17w, Rooks County. Other outposts were showing oil and indicating extensions to the South Silica pool in Barton County, Eichman pool in Russell County, and the Hall and Coralena pools in Russell County. The pool opener in Section 10-27-10w, Kingman County, was being tested after acidizing. Previously, it produced 75 bbls. of oil naturally.

ILLINOIS—The Illinois Geological Survey estimates the Central basin fields discovered in the past two years to contain 32,000 acres and the reserve of oil uncovered as 224,000,000 bbls. It is interesting to note that the combined productive acreage is less than one-fourth that of the East Texas field and a little more than one-third that of the Bradford field in Pennsylvania and New York. However, only a very small part of the basin has been explored.

TEXAS—Three wildcats in Andrews County, West Texas, show indications of oil. New pools loom in Jones and Shackelford counties in Central Texas. The Sun field in Starr County, Southwest Texas, was extended a half mile northerly. The Kelsey field in Jim Hogg County was extended northward. Two wildcats on the Conroe trend in Texas and South Louisiana have shown evidence of commercial production. Distillate production in Terrebonne Parish, Louisiana coastal area, was developed in the 10,000-foot horizon. In Montague County in North Texas a wildcat showed signs of production in the 4,100-foot horizon but later went to water. King Oil Co. No. 8 Pettit in the K.M.A. field has 101 feet of pay in the deep sand and is expected to make one of the largest wells in the field.

LA-ARK-TEX—A dry hole southwest of Shreveport cuts off production in that direction. The Magnolia field in Columbia County, Arkansas, continues to revive as the Vaughn No. 2 Garrett produces 425 bbls. per day through quarter-inch choke and the Atlantic Refining Co. test northeast of the Garrett well shows oil on drill stem test. The Rodessa field in Miller County was extended another half mile.

MICHIGAN—Clare County, with seven new wells, increased its potential production 18,000 bbls. a day. The Freeman field in Clare is the most active in the state. It is being prorated this week by producers and buyers as its new production threatens the crude market.

CALIFORNIA—The Coles Levee and the Tupman areas in Kern County give promise of two new oil fields.

WYOMING—MacKinnie Drilling Co. has a 2,400-bbl. well in the Lance Creek field, producing from Leo sand. An old well in Elk Basin, deepened 56 feet by Stanolind Oil & Gas Co., develops a production of 20,000,000 feet of gas per day.

Completions in All Fields

(Week Ending November 12, 1938)

	Oil	Gas	Dry	Total	1938 total comp. to date	1937 total comp. to date
N. Y., Pa. and W. Va.	36	19	2	57	3,106	4,075
Ohio	5	8	2	15	844	1,073
Indiana	5	7	8	20	121	105
Kentucky	16	0	7	23	785	619
Illinois	79	2	13	94	1,665	245
Michigan	13	0	4	17	805	706
Kansas	19	0	10	29	1,412	2,324
Oklahoma	30	2	4	36	1,497	2,338
Texas:						
North Central Texas	21	2	15	38	2,713	2,434
West Texas	24	0	4	28	1,711	2,343
Texas Panhandle	5	2	0	7	495	701
East Texas	22	0	0	22	1,587	2,097
East Central Texas	2	1	0	3	305	640
East Texas Border	2	0	0	2	120	298
Gulf Coast Texas	27	1	4	32	1,161	1,364
Southwest Texas	29	1	16	46	1,882	2,841
Total Texas	132	7	39	178	9,974	12,718
North Louisiana	6	2	3	11	557	573
Gulf Coast Louisiana	7	0	1	8	420	396
Total Louisiana	13	2	4	19	977	969
Arkansas	6	0	0	6	214	151
Montana	0	0	2	2	95	205
Wyoming	2	1	0	3	138	96
Colorado	0	0	0	0	11	18
New Mexico	5	0	2	7	485	621
Utah	0	0	0	0	2	3
California	22	2	5	29	1,127	1,311
Total United States	383	50	102	535	23,258	27,577
Total previous week	383	39	117	539		
Week ending Nov. 13, 1937	445	70	115	630		

Outstanding Fields--Highlights

(Week Ending November 12, 1938)

FIELD—	Rigs up	Wells drlg.	Weekly oil completions	Initial prod.	Total No. oil wells	Daily av. prod.
TEXAS						
K.M.A.	32	41	5	3,267	858	16,450
Wasson-Bennett	12	32	4	2,711	168	11,312
Ector County	12	53	9	8,065	1,356	48,050
Winkler County	6	15	1	226	1,723	35,840
Howard-Glasscock	4	23	1	1,522	1,023	14,760
East Texas	27	42	22	1,126	25,789	370,400
OKLAHOMA						
St. Louis	6	31	4	950	719	24,400
Oklahoma City	3	8	0	0	1,094	105,275
KANSAS						
Barton County	3	19	4	1,650	385	9,650
Stafford County	4	16	2	910	196	4,100
Rice County	2	14	2	985	1,237	26,400
Russell County	2	22	3	840	1,160	21,275
NEW MEXICO						
Lea County	7	85	5	1,365	1,913	100,580
LA-ARK-TEX						
Rodessa, La-Ark-Tex	1	14	2	515	1,041	65,200
Cotton Valley, La. (deep)	1	20	1	595	97	11,065
Schuler, Ark.	2	16	4	6,355	119	16,985
Jennings, La.	2	13	0	0	124	24,390
MICHIGAN						
Freeman	8	28	6	7,800	29	7,520
ILLINOIS						
Central Illinois	66	409	79	22,599	1,589	75,128
CALIFORNIA						
Wilmington	5	12	2	889	573	95,200
KENTUCKY						
Birk City	4	15	5	700	92	3,225

Illinois and Kentucky

By STAFF CORRESPONDENT

Marion Leads With 40 New Wells Out of a Total of 79

MATTOON, Ill., Nov. 14.—Seventy-nine oil wells, 13 dry holes and two gas wells comprised the completion record of the past week in Illinois. In the same period 113 new operations were announced, including drilling wells, derricks and locations made.

Marion County led in completions with 40 oil wells, with an initial production of 11,665 bbls., and five dry holes; Fayette reported 20 new oil wells, with initial production of 5,004 bbls., and three dry holes; Clinton, six oil wells, initial production 296 bbls., no dry holes; Crawford County, one 80-bbl. oil well; Jefferson County, two oil wells with initial production of 1,424 bbls. and one dry hole; Clay County, six oil wells, initial production 2,706 bbls., no dry holes; Wayne County, four oil wells, initial production 1,424 bbls., one dry hole. Two gas wells with a combined initial production of 25,000,000 feet were completed in Lawrence County. One dry hole in Hancock County, and four dry holes in Shelby County, were among the completions.

Dr. M. M. Leighton, state geologist, reports the newly developed Illinois fields embrace a proved area of 32,000 acres and contain a reserve of 224,000,000 bbls. of oil as of October 1 this year. Dr. Leighton reports that this year's discoveries in the state include 11 pools, bringing the total in the Illinois basin area to 15. He gave the number of oil wells in the basin area on October 1 as 1,180.

Another outlet for the big Lake Centralia-Salem field in Marion County is promised soon with the completion of the Manly Oil Corp.'s pipe line which will run from the field to C. B. & Q. loading racks in South Centralia. The line will be 5 miles in length, of 4-inch pipe, and will supply oil to Centralia refineries direct and to northern refiners by rail. The company is making progress with all possible speed as there is urgent need for pipe line connections in the field.

In the following completion report, the production represents the first 24-hour output of the wells unless otherwise stated.

Marion County

In Marion County, Centralia Coal Co. No. 5 fee, NE cor. SW SW SW Section 18-1n-1e, Centralia field, Cypress sand at 1,210-17 feet, pumped 25 bbls. Menhall No. 9 I.C.R.R., SE cor. NE NW NW Secion 19-1n-1e, Benoist at 1,376-88 feet, shot with 10 quarts, pumped 30 bbls. In the Lake Centralia area, W. B. Curry No. 1 Hawthorne, NW SW SE Section 5-1n-2e, Benoist top at 1,741 feet, total depth 1,793 feet, flowed 225 bbls. through 2-inch tubing. Texas Co. No. 2 City of Centralia land, SW cor. NW SW NE Section 5-1n-2e, Benoist sand at 1,692-95 feet, flowed 150 bbls. through 19/16-inch choke. Texas No. 2-C Richards, NE cor. SE Section 6-1n-2e, pay at 1,777-95 feet and 1,801 feet, total depth 1,828 feet, will not complete at present. Ohio Oil Co. No. 2 B. L. Murray, NE SW SE Section 7-1n-2e, shot with 20 quarts at 1,875-95 feet, flowed 202 bbls. in 12 hours and then quit. Aux Vases lime was topped at 1,855 feet, Benoist sand was topped at 1,808 feet. Texas Co. No. 2 Foster, NW NE SE Section 7-1n-2e, Benoist at 1,850-90 feet flowed 146 bbls. through half-inch choke. Texas No. 3 Foster, NE NE SE Section 7-1n-2e, Benoist sand at 1,764 feet, total depth 1,795 feet, flowed 350 bbls., estimated. Texas No. 1 Foster, NE NW SW Section 8-1n-2e, Benoist at 1,786 feet, total depth 1,818 feet, flowed 135 bbls. Mammoth Producing & Refining Co. No. 6 Bachman, SE NE SW Section 9-1n-2e, Benoist at 1,858-64 feet, total depth, pumped 155 bbls. Kingwood Oil Co. No. 3 Devor, NE NW NW Section 17-1n-2e, Benoist at 1,840-63 feet, flowed 168 bbls. J. J. Deaner No. 4 Burge, SW NW NE Section 18-1n-2e, dry and abandoned at 1,945 feet, Benoist topped at 1,908 feet. Tide Water Associated Oil Co. No. 2 Miller, NW NE NE Section 15-1n-2e, Benoist sand at 1,857-84 feet, pumped 135 bbls. Tom Boyce No. 1 Stoner, SE NE NW Section 30-1n-2e, dry and abandoned at 1,835 feet, no Benoist reported. R. E. Dalton No. 1 Clifton, NE cor. SE SW Section 15-1n-4e, shut down at 3,029 feet with 2,900 feet of drill pipe in the hole.

Nash Redwine and others No. 1 Pruden, SW SW NW Section 10-2n-2e in the Salem area, shut down at 1,977 feet, Bethel sand at 1,967-74 feet contained water. Kingwood & Bell No 4 Shanafelt, SW NW NE Section 20-2n-2e, Benoist at 1,756-1,805 feet, flowed 330 bbls. through 2½-inch tubing. Ohio Oil Co. No. 1 M. J. Young, SE SE NW Section 20-2n-2e, Benoist at 1,754-78 feet, flowed 221 bbls. Magnolia Petroleum Co. NW NW NW Section 21-2n-2e, Benoist top at 1,789 feet, total depth 1,842 feet, flowed 336 bbls. Magnolia No. 7 W. B. Young, NW NW SW Section 21-2n-2e, Benoist top at 1,765 feet, total depth 1,814 feet, flowed 192 bbls. Magnolia No. 8 W. B. Young, NE NW SW Section 12-2n-2e, Benoist top at 1,785 feet, total depth 1,818 feet flowed 240 bbls. Texas Co. No. 1 Lee, SE SE SW Section 28-2n-2e, Benoist at 1,737-52 feet, flowed 159 bbls. Texas No. 2 M. Lee, SW SW SW Section 28-2n-2e, Benoist top at 1,721 feet, total depth 1,769 feet, flowed 210 bbls., estimated. Magnolia Petroleum Co. No. 7 Shanafelt, SW SW SE Section 29-2n-2e, Benoist top at 1,717 feet, total depth 1,779 feet, flowed 240 bbls. Magnolia No. 8 Shanafelt, SW NW SE Section 29-2n-2e, Benoist top at 1,726 feet, total depth 1,748 feet, flowed 380 bbls. Magnolia No. 3 J. B. Young, SW NE NE Section 29-2n-2e, Benoist top at 1,733 feet, total depth 1,781 feet, flowed 288 bbls. Magnolia No. 5 J. B. Young, NE SW NE Section 29-2n-2e, Benoist top at 1,736 feet, total depth 1,774 feet, swabbed 216 bbls. through casing. Magnolia No. 6 J. B. Young, SW NW NE Section 29-2n12e, Benoist top at 1,738 feet, total depth 1,783 feet, flowed 360 bbls.

Texas Co. No. 3 Fossick, NE NE SW Section 29-2n-2e, Benoist top at 1,721 feet, total depth 1,784 feet, flowed 700 bbls., estimated. Texas No. 4 Fossick, NE cor. SW Section 29-2n-2e, Benoist top at 1,719 feet, total depth 1,775 feet, flowed 420 bbls. Texas No. 5 Fossick, SE SE NW Section 29-2n-2e, Benoist top at 1,740 feet, total depth 1,780 feet, flowed 280 bbls., estimated. Texas No. 9 Freidrich, NW SW SW Section 29-2n-2e, Benoist top at 1,714 feet, total depth 1,769 feet, flowed 560 bbls., estimated. Texas No. 3 L. Dunning, NE SE SE Section 30-2n-2e, Benoist top at 1,732 feet, total depth 1,782 feet, flowed 1,140 bbls., estimated. Texas No. 3 H. V. Corbin, SW SE NE Section 31-2n-2e, Benoist top at 1,636 feet, total depth 1,683 feet, flowed 600 bbls., estimated. Magnolia Petroleum Co. No. 4 D. A. Shanafelt, SE cor. SW NE NE Section 32-2n-2e, Benoist top at 1,750 feet, total depth 1,793 feet, pumped 264 bbls. Shell No. 4 Farthing, SE NE SW NE Section 32-2n-2e Benoist top at 1,739 feet, total depth 1,790 feet, flowed 456 bbls. Texas Co. No. 3 Miller, NW cor. NE NE SE Section 32-2n-2e, Benoist top at 1,751 feet, total depth 1,820 feet, flowed 750 bbls., estimated. Texas No. 1 Easley, SE cor. NW Section 33-2n-2e, Benoist top at 1,834 feet, total depth 1,883 feet, flowed 220 bbls., estimated. Texas No. 2 Easley, SW SW NE Section 33-2n-2e, Benoist at 1,843 feet, total depth 1,890 feet, flowed 400 bbls., estimated. Texas No. 3 Easley, SW cor. SW NE Section 33-2n-2e, Benoist top at 1,849 feet, total depth 1,898 feet, flowed 175 bbls., estimated. Garner Bros. No. 1 Mulvaney, SE NE SE Section 6-2n-4e, McClosky top at 2,766 feet, total depth 2,850 feet, dry and abandoned. Benoist sand was at 2,560-87 feet.

Adams Oil & Gas Co. No. 3 Cox, NE NE SE Section 29-4n-1e, Patoka district, Benoist at 1,418-48, feet pumped 58 bbls. Adams No. 2 Sam Pugh, SE NW SE Section 29-4n-1e, shot with 10 quarts at 1,424-28 feet, pumped 25 bbls. It had been drilled to 1,675 feet and plugged back. Conrey & Griffin No. 1 Bilek, NW NW NW Section 26-4n-2e, McClosky at 2,160 feet, total depth 2,211 feet, dry and abandoned.

Devonian Oil Co. No. 1 Schubert, NW NE SW Section 24-3n-3e, McClosky top at 2,515 feet, total depth 2,560 feet, dry and abandoned. Kingwood Oil Co. No. 1 Elliott, NW SE NE Section 13-23n-6e, pay at 2,968-77 feet.

Fayette County

In Fayette County, the Texas Co. No. 1 Chrisman, NE NE SW Section 30-6n-3e, Weiler sand at 1,590-1,620 feet, pumped 132 bbls. Magnolia Petroleum Co. No. 5 Clow, SE SW NE Section 5-7n-3e, Benoist sand at 1,562-93 feet, flowed 230 bbls. Magnolia No. 6 Clow, SW SE NE Section 5-7n-3e, Benoist at 1,541-73 feet, flowed 120 bbls. Magnolia No. 7 Clow, SE SE NE Section 5-7n-3e, Benoist sand at 1,534-57 feet, swabbed 300 bbls. J. E. Mabee No. 1 Lay, SE cor. NW SW Section 6-7n-3e, Weiler sand at 1,448-84 feet, shot with 25 quarts pumped 175 bbls. Carter Oil Co. No. 1 Townsend, SE NW NW Section 7-7n-3e, total depth 1,591 feet, plugged back to 1,547 feet and shot with 25 quarts in stray sand at 1,535-47 feet pumped 114 bbls. of oil and 75 bbls. of water. C. F. Steele No. 1 Arnold, NW cor. SW SW Section 8-7n-3e, Bethel sand at 1,521-48 feet, shot with 20 quarts pumped 150 bbls. Carter Oil Co. No. 1 Emma McCormick, SE SW SE Section 18-7n-3e, total depth 1,583 feet, with Bethel sand 1,579-83 feet, ripped pipe at 1,476-1,502 feet and swabbed 130 bbls. from Weiler sand at 1,478,-1,509 feet. Carter Oil Co. No. 2 Emma McCormick, SE SW NE Section 18-7n-3e, stray sand at 1,579-83 feet, shot with 10 quarts, swabbed 193 bbls. Luttrell & Holleman No. 1 railroad right of way, NW cor. NE NW Section 18-7n-3e, Weiler at 1,488-99 feet, pumped 150 bbls. Max Pray No. 4 Ferguson, NW NW NW Section 18-7n-3e, Weiler sand at 1,519-35 feet, shot with 20 quarts on bottom, pumped 264 bbls. Shell Petroleum Corp. No. 2 Harper, SW SE NE Section 18-7n-3e, total depth 1,606 feet, plugged back to 1,599 feet and pumped 53 bbls. of oil and 97 bbls. of water from Benoist sand which lay at 1,596-1,606 feet but which showed water on bottom. Sherman and others No. 9 Burtschi, NE NE SE Section 18-7n-3e, Benoist at 1,587-1,602 feet, shot with 15 quarts, pumped 150 bbls. with a showing of water. Doran & Hynes No. 1 C. H Moore, SE SW NE Section 33-8n-1e, total depth 1,640 feet, no show of oil, abandoned. Carter Oil Co. No. 2 Matson, SW NW SE Section 11-8n-3e, Bethel sand at 1,497-1,531 feet, shot with 60 quarts, flowed 781 bbls. Carter Oil No. 1 Henry Cline, NW NW

Illinois Fields

HIGHLIGHTS OF THE WEEK: Dr. M. M. Leighton, head of the Illinois Geological Survey, estimates that the Central basin fields cover 32,000 acres already proven as oil producing, and that they represent a reserve of 224,000,000 bbls. of oil.

Daily production of new pools, 75,128 bbls.; old pools, 11,476 bbls.; total, 86,604 bbls.

Completed oil wells, 79; operations including locations, rigs and drilling wells, 580.

SE Section 14-8n-3e, Weller sand at 1,490-1,515 feet, flowed 940 bbls. Carter No. 1 Hopper, NE SW NW Section 14-8n-3e, Bethel sand at 1,547,52 feet, flowed 167 bbls. of oil and 65,400 feet of gas. Carter No. 1 Fair, SE SW SW Section 29-8n-3e, Bethel at 1,541-71 feet, shot with 60 quarts, pumped 164 bbls. Carter No. 2 Kimbrell, NW SE NW Section 29-8n-3e, Bethel at 1,567-87 feet, shot with 40 quarts, pumped 101 bbls. Carter No. 3 Dial, SE SE NW Section 33-8n-3e, Bethel at 1,555-78 feet, shot with 50 quarts, flowed 650 bbls. Minerva Oil Co. No. 7 Tish, NW SW SE Section 33-8n-3e, total depth 1,612 feet, plugged back to 1,490 feet, Weller sand at 1,481-95 feet, pumped 40 bbls. Continental Oil Co. No. 1 Bertlett, NE NW NE Section 30-9n-1e, Roseclaire at 1,659 feet, total depth 1,775 feet, dry and abandoned.

Longoria and others No. 1 Braasch, NE NE SW Section 1-5n-2e, dry and abandoned at 1,823 feet.

Clinton County

In Clinton County, Centralia pool, Shell Petroleum Corp. No. 1 Hanseman, SE NW SE Section 1-1n-1w, Benoist sand at 1,333-50 feet, shot with 10 quarts, pumped 19 bbls. of oil and 2 bbls. of water in 12 hours. Shell Petroleum Corp. No. 9 Criley, NE NW NE Section 2-1n-1w, Benoist at 1,342-71 feet, shot with 21 quarts, pumped 142 bbls. Shell No. 10 Criley, SE NW NE Section 2-1n-1w, Benoist at 1,349-64 feet, shot with 20 quarts, pumped 91 bbls. Shell No. 10 Allison, SE cor. SW NE Section 12-1n-1w, Benoist at 1,366-82 feet, shot with 10 quarts, pumped 75 bbls. Hawley Oil & Gas Co. No. 1 Chester Carter, NE NE NE Section 24-1n-1w, Stein sand at 1,235-45 feet, Benoist at 1,361-81 feet, shot with 20 quarts, pumped 2 bbls. Santa Fe Oil & Gas Co. No. 7 Robbins, NW cor. SW SE Section 7-1n-3w, Bartelso pool, Cypress sand at 968-83 feet, shot with 30 quarts, pumped 65 bbls.

In Hancock County, Mike Callahan and others No. 1 J. D. Hall, NE SE NE Section 1-3n-5w of fourth meridian was reported abandoned at 568 feet.

In Lawrence County, Herbst and others No. 1 Brown & Null, C SE SW Section 12-4n-11w of first meridian, Buchanan pay at 1,136-40 feet, 16,000,000 feet of gas, casing pressure 400 pounds. Kentucky Natural Gas Co. and Parriott No. 1 Hayes, NE cor. SW NW NE Section 13-4n-11w, Buchanan sand at 1,054-57 feet, 9,000,000 feet of gas.

In Crawford County, Ohio Oil Co. No. 6 Schumaker, NE cor. SW Section 20-7n-14w, of first meridian, an old well deepened from 981 feet, found pay at 1,435-40 feet, acidized it with 2,000 gallons and well pumped 80 bbls.

Jefferson County

In Jefferson County, Benedum & Trees No. 1 Jefferson Oil & Gas Co., C NW NE Section 16-4s-2e, total depth 2,955 feet, plugged back to 2,751 feet, McClosky lime, perforated casing at 2,730-53 feet, pumped 20 bbls. of oil and 125 bbls. of water. Carter Oil Co. No. 1 Allen, SE NW NE Section 9-1s-2e, Bethel sand at 1,939-54 feet, shot with 15 quarts, pumped 230 bbls.

Clay County

In Clay County, Pure Oil Co. No. 7 Weiler, C E half NW NW Section 4-2n-8e, pay at 2,950 feet, total depth 3,062 feet, acidized with 5,000 gallons, pumped 219 bbls. Pure No. 1 McAllister, C W half NW NW Section 15-2n-8e, Fredonia lime at 2,982 feet, total depth 3,095 feet, pumped 977 bbls. Pure Oil Co. No. 3 Charles R. Bunn B, C W half NW NE Section 17-2n-8e, pay topped at 3,007 feet, total depth 3,105 feet, pumped 159 bbls. Pure Oil Co. No. 8 C. B. Clay, C W half SE SE Section 22-1n-7e, McClosky at 3,113-22 feet, flowed 397 bbls. through 28/64-inch choke. Pure No. 7 Clay, C W half SE NW Section 27-1n-7e, pay at 3,136-38 feet pumped 95 bbls. of oil and 126 bbls. of water. Pure Oil Co. No. 5 Duff B, C W half SE SE Section 32-2n-8e, pay at 2,960-71 feet, acidized with 5,000 gallons, flowed 859 bbls.

Wayne County

In Wayne County, Texas Co. No. 1 Harris, NW NW NW Section 4-3s-7e, pay at 3,316-44 feet, flowed 608 bbls. through 1-inch choke. Rockhill No. 3 Twist A, SE NE SE Section 32-2s-7e, McClosky pay at 3,329-44 feet, flowed 250 bbls. Texas Co. No. 2 Lyons, SE SE SE Section 32-2s-7e, McClosky at 3,319-42 feet, flowed 350 bbls. in 12 hours through 1-inch choke. H. H. Weinert No. 3 Morlan B, SE NW NE Section 33-2s-7e, pay at 3,318-22 feet, flowed 216 bbls. Martin & Stokes No. 1 Dave Shaeffer, NW cor. NE NW NW Section 8-2s-8e, total depth 3,384 feet, plugged back to 3,284 feet and given drill stem tests recovering only mud with a small showing of oil, dry and abandoned.

In Shelby County, A. A. Baker No. 1 L. Garrett, NE SE SE Section 9-9n-3e, Fredonia lime at 1,960 feet, total depth 2,009 feet, dry and abandoned. Carter Oil Co. No. 1 Banning, SW SE SE Section 15-9n-3e, total depth 1,716 feet, dry and abandoned. Benoist sand was topped at 1,711 feet. Dan Moore and others No. 1 Clay estate, NE SE NW Section 24-10-3e, total depth 1,700 feet, dry and abandoned. Bethel sand topped at 1,693 feet. Ogg & Jolly No. 1 Jenkins, SE cor. Section 26-10n-4e, total depth 1,900 feet, dry and abandoned. Stein sand at 1,706 feet.

New Wildcat Operations

In Perry County, L. C. Summell and others No. 1 Walter Kinzey, 1,300 feet from S and 1,050 from E lines SE quarter Section 6-5s-1w, Benoist sand at 1,350 feet, dry, drilling at 1,390 feet. Bert Fields & Rockhill No. 1 Provert Estate, SW SE SE Section 27-5s-1w, location.

In Fayette County, Mylius and others No. 1 Freezel, SE NE SW Section 8-6n-3e, location.

In Coles County, East Oakland Syndicate No. 1 W. J. Temple, SW cor. SE NE Section 36-14n-10e, drilling at 105 feet.

In Gallatin County, J. Garfield Buell No. 1 Sutter, C NW NW Section 5-8s-10e, location.

In Jefferson County, Benedum & Trees No. 1 Interstate Coal Co., NE NE SW Section 9-4s-2e, rigging up rotary.

In Wayne County, Al. Stengle and others No. 1 Harris, SE NW NW Section 8-3s-9e, derrick. Roche & Boyles No. 1 McPherson, C S half SE NE Section 4-2s-7e, moving in rotary. Carl Robinson No. 1 Felix, SW SE SE Section 27-2s-8e, set 10-inch casing at 150 feet.

In Jefferson County, O. L. Ray No. 1 Simon heirs, NE cor. NW Section 12-1s-3e, derrick. Minerva Oil Co. No. 1 Warren, SE SE SE Section 18-1s-4e, rigging up rotary.

In Marion County, Hull, Stauffer and others No. 1 Marlin, NE NW cor. SW SW SW Section 10-2n-2e, derrick. Pyramid Oil Co. No. 1 Roddy, SW cor. SE SW Section 20-2n-2e, deepening at 2,280 feet, old total depth 2,207 feet.

In Fayette County, A. J. Baxter No. 1 Sigler, NE SE SE Section 1-5n-2e, spudded.

In Clay County, Richard Duncan No. 1 Liggett, SE NW SE Section 17-5n-5e, rigging up rotary.

Wildcat Progress

In Marion County, Blair and others No. 1 Eggering, NE SE SW Section 12-1n-1e, was drilling below 1,810 feet; J. J. Broadus No. 1 Whitechurch, 75 feet from E and 750 feet from N lines NE quarter Section 12-1n-1w, drilling at 1,300 feet; Hawley Oil & Gas Co. No. 1 Capple, SW SW NE Section 28-1n-1e, drilling at 1,308 feet.

In Fayette County, Lindsey and others No. 1 Bowers, SW NE SE Section 36-4n-1w, was drilling at 932 feet; W. C. Stevenson No. 1 Harkless, C NE SE NE Section 30-5n-1e, coring at 1,550 feet; Hurricane Creek Oil Co. No. 1 Eckard, C NW NE Section 15-6n-1w, shut down at 1,755 feet; Putnam and others No. 1 Surley, C SE SE Section 35-6n-1w, underreaming 6-inch casing to 1,305 feet; Mamouth & Murphy No. 1 Neal, C SW SE NE Section 32-6n-3e, drilling at 1,790 feet; Ulrich & Pough No. 1 Durbin, C NW NW SW Section 31-9n-3e, coring at 1,600 feet.

In Shelby County, Kingwood Oil Co. No. 1 Vogel, C SE NE NW Section 1-9n-4e, has derrick up.

In Bond County, Huppard and others No. 1 Dresser, SW NE NW Section 21-6n-4w, was reacidized at 1,800-30 feet, and put on the pump, but had not been tested when this report was made. This well tested 2 bbls. of oil per hour when bailed following its first acid treatment. Devonian lime top was found at 1,775 feet,

(Continued on Page 236)

Birk City Had an Off Week in Results of Completed Work

OWENSBORO, Ky., Nov. 14.—Twelve new oil wells and seven dry holes were completed in the Western Kentucky fields in the past week.

The Birk City field's record of completions included the following: Aetna Oil Service Corp. No. 4 Morrison had 4½ feet of saturation in the McClosky lime, total depth of 1,888 feet. It was acidized with 4,000 gallons and flowed 25 bbls. the first day. A. H. Carpenter and others No. 1 G. M. Morrison is a 200-bbl. well at a total depth of 1,874 feet. It was acidized with 4,000 gallons. Same operators' No. 2 Mrs. Sapp, acidized with 4,000 gallons, made an estimated 250-bbl. initial producer at a total depth of 1,877 feet. Same operators' No. 1 Arthur Swartz was dry and abandoned at 1,912 feet. Western Petroleum Corp. No. 1 Dr. Tyler was a dry hole at 1,907 feet. Major Oil Co. completed No. 1 Miranda Wahl. It swabbed 100 bbls. of oil in four hours. Total depth is 1,930 feet. The well had not been acidized. On the Henderson County side of the field, Sun Oil Co. and Kentucky Natural Gas Co. No. 2 Mrs. Duncan, total depth 2,073 feet, started at 125 bbls. a day, naturally.

Other completions in the district, and new operations were as follows:

Butler County, Huntsville district: H. C. Darby and others No. 1 Roy Blaine, dry hole, total depth 465 feet; H. C. Darby and others No. 1 Ellis Blaine, drilling at 120 feet. Silver City district: Fred Phillips & Evans No. 3 J. D. Brown, 5 bbls., Jones sand, total depth 485 feet; Fred Phillips & Evans No. 4 J. D. Brown, location; J. C. Miller, Trustee, No. 4 Martha Haws, 20-bbl. well, Jackson sand, total depth 521 feet. Quality district: Interstate Oil & Gas Co. and others No. 1 Forgy Heirs, location. South Hill district: W. R. Jackson and others No. 1 L. Holman, spudding in. Glancer district: Snowden & McSweeney and others No. 1 Bud Lacefield, dry hole, total depth 607 feet.

Daviess County, Utica district: A. D. Shaffer and others No. 5 Boyd Britow, spudding in; Chenault & Farmer No. 3 Martin Weaver, 10-bbl. well, Jones sand, total depth 1,238 feet. Birk City district: C. Cordell No. 1 Anna Fisher, moving in; Snowden & McSweeney No. 2 Helen Fisher, total depth 1,894 feet, acidizing; Major Oil Co. No. 2 Mrs. Helen Harrington, drilling at 100 feet, going for Jett gas; Aetna Oil Service Corp. No. 1 Henry Miller, spudding in; Whitesville district: Ashby & Ellis No. 3 W. M. Holland, dry hole, total depth 623 feet.

Hancock County, Easton district: James C. Ellis No. 20 R. A. Richards, 40-bbl. well, Jett sand; No. 21, spudding in; Chester Oil Co. No. 15 J. W. Baughn, drilling at 150 feet. Patesville district: C. T. Johnson and others No. 15 Gordon & Lynch, 5-bbl. well, Jett sand, total depth 222 feet.

Henderson County, Baskett district: R. D. Baker and others No. 1 Strother Banks, spudding in. Cairo district: Bur-Kan Oil Co. No. 1 H. P. Barrett, dry hole, total depth 2,548 feet; Phillips Petroleum Co. No. 1 F. P. Royster, McClosky oil show 2,555-61 feet, total depth 2,622 feet, will not make a well. Birk City district: Phillips Petroleum Co. and W. E. Hupp No. 1 H. E. Jones, total depth 2,140 feet, acid not effective, shut down, may plug; Carter Oil Co. No. 3 L. N. Mauzy, cored McClosky lime at 1,913-22 feet.

Hopkins County, Mortons Gap district: Jess Ashby and others No. 1 Mrs. A. R. Cummings, dry hole, total depth 2,147 feet.

McLean County, Buel district: Fred Phillips Oil Co. No. 1 J. E. Arnold, rigging up. South Livermore district: J. D. Reynolds and others No. 5 H. Howell, drilling at 900 feet. Johnson School district: W. H. Hodnett and others No. 1 Less Igleheart, drilling at 340 feet.

Muhlenburg County, Belton district: Fred Phillips Oil Co. No. 1 Boggess, moving in.

Ohio County, Narrows district: W. E. Hupp and others No. 1 Oscar Schultz, drilling 250 feet; Jointer & Levine No. 2 Sam Davidson North tract, 20-bbl. well in McClosky, total depth 683 feet; No. 3 moving in; Mecca Oil Co. No. 4 Sam Davidson South tract, shut down, waiting to acidize. Cumberland Petroleum Co. No. 2 Sam Davidson 100-acre tract, moving in; McLaughlin and others No. 3 T. P. Fertress, drilling 140 feet. Ralph district: Globe Oil Co. No. 3 Ada Kelley, 5-bbl. well in Jones sand. Oklahoma district: Henry Scholl No. 5 Oscar Westerfield, spudding in.

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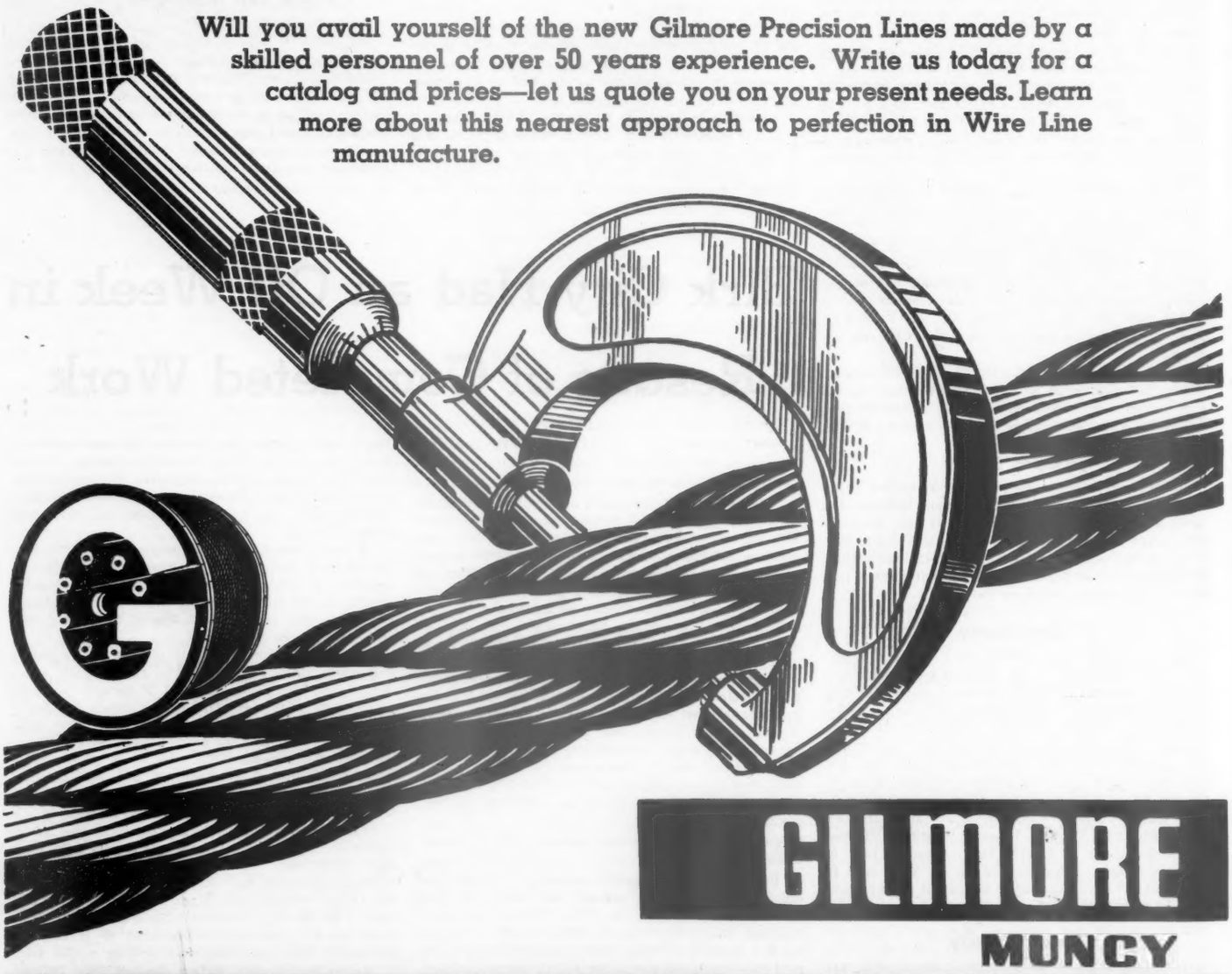

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Eastern Field Report

By STAFF CORRESPONDENT

Western Penna. Deep Tests Are Making Good Progress

PITTSBURGH, Pa., Nov. 14.—The rotary test of the Peoples Natural Gas Co. on the Piedmont Coal Co. lease in South Union Township, Fayette County, on Chestnut Ridge, continues to make fast time in comparison with standard tools. At present the depth is 6,228 feet and tentatively the Tully lime has been placed at 5,960-6,075 feet, or approximately 38 feet higher on structure than the Summit Hotel (Heyn) No. 2.

South along this ridge in this township, New Penn Development Co., William E. Snee and others are drilling at 4,430 feet on the Indian Creek Coal Co. William Johnson warrant. In Springhill Township, farther south and about 1.1 miles above the state line, L. J. Houze Convex Glass Co. is drilling at 7,500 feet in the test on the Paul Dunham farm and appears to still be in the Marcellus, which section has thickened up considerably.

In North Union Township, Fayette County, and on Chestnut Ridge, Wasson & Co. are drilling at 6,576 feet on the J. H. Sorg farm. The Onondaga should be reached within the week.

SOUTHEASTERN OHIO

In southeastern Ohio, Pure Oil Co. test on the Mary E. Clark farm, in Section 11, Jackson Township, Knox County, was completed in Clinton sand at 3,193 feet, and produced 65 bbls. the first day after shot.

In Licking County, Guy T. Shrider and others completed a test on the Emma Davis farm in Section 8, Mary Ann Township, in Berea sand at 705 feet. It produced 10 bbls. the first day after shot.

In Muskingum County, the test of the Wittmer Co. on the Howard H. Bowden No. 2 lease, in Lot 8, Washington Township, was a failure in the Clinton sand. It was drilled to 4,081 feet with the Clinton topped at 3,974-4,006 feet.

In Harrison County, Columbian Carbon Co. is getting ready to start a test on the George D. Miller farm, in C NE NE NW Section 23, German Township.

SOUTHWEST PENNSYLVANIA

In Fayette County, Pennsylvania, Fox Brothers completed a second test on the Rick farm in Menallen Township in the Big Injun sand and it is estimated good for 125,000 feet a day. The initial well on this farm gauged in excess of 4,000,000 feet. In this township, Nollem Oil & Gas Co. is drilling at 628 feet on the Victor Piccolamini farm.

In Indiana County, Equitable Gas Co. completed No. 3239, on the Clayton Alshouse farm in South Mahoning Township, with 54,000 feet of gas a day from the Big Injun, Speechley, and Bradford sands and a total depth of 3,653½ feet. In this township, this company will drill on the Henderson Whitesell farm, elevation 1,296 feet, and on Savings & Trust Co. of Indiana land, elevation 1,369 feet.

In Greene County, the Equitable Gas Co. completed deepening No. 1 Burns Bell in Washington Township at 3,004 feet with the Fourth sand at 2,979 feet, and 450,000 feet of gas at 2,981-86 feet. In this township, this company is drilling at 587 feet in No. 3 T. J. Huffman, and at 2,205 feet deepening No. 1 T. J. Ross.

In Washington County, Beedle, Clark and others completed the second test on the Pittsburgh Coal Co. lease in Nottingham Township, at 2,805 feet. Fifth sand was at 2,586-2,608 feet with 100,000 feet of gas at 2,590-92 feet.

In North Strabane Township, Washington County, Keystone Drilling Co. is rigging up on the Frank Grego farm. In South Franklin Township, J. J. Foley & Co. were drilling below 500 feet on the Ira Baldwin farm. In South Strabane Township, A. V. Lewis and others have No. 13 started on the Frank J. Wilson farm.

In Hanover Township, Washington County, Kenneth Aten & Co. were drilling on the A. Vance farm at 376 feet. In Chartiers Township, the Cannonsburg Steel & Iron Co. had reached 1,170 feet on their own property.

Greene County

In Monongahela Township, Greene County, Brummage & Brummage have rig on the ground on the S. G. Durr farm, and Monomgahela Oil & Gas Co. is down 1,175 feet on the Vance heirs farm.

In Center Township, Carnegie Natural Gas Co. started drilling No. 3 J. H. Orndoff. J. B. Orndoff is fishing for the top string of tools in No. 3 G. M. Scott. In Greene Township, Equitable Gas Co. is down 210 feet on the George W. Hixenbaugh farm, elevation 1,110 feet.

In Morris Township, Furman Nuss and others were drilling at 1,647 feet on the C. W. Ewings farm. In Monongahela Township, O. I. Dille is drilling at 600 feet on the Elmer D. Beckham farm.

Mercer County Deep Test

Carnegie Natural Gas Co. topped Onondaga limestone at 3,604 feet on the A. S. McCullough farm at Big Bend, in Jefferson Township, Mercer County, and is drilling at 3,725 feet, or 121 feet in that formation.

WEST VIRGINIA

Only one small producer was completed in West Virginia during the week. There, also, South Penn Oil Co., largest purchaser of Pennsylvania Grade crude, has notified the producers in West Virginia with whom it contracts for the purchase of oil as run, that the company will buy only 75 per cent of the amount run during October, 1938. A decreased market for the crude is given as the reason. This purchasing agency is also refusing to purchase oil from new accounts. With this damper on the market, little new oil production will be sought until the market is rectified.

In Pleasants County, Wilson & Smith completed the second test on the W. A. Wilson farm in McKim district in the Big Injun sand at 1,680 feet and it is good for 2 bbls. a day along with about 20,000 feet of gas.

Gas Wells

In Cabell County, Lower Toms Creek Gas Co. completed a gas well good for 220,000 feet per day on the Ida D. Ramsey farm in McComas district at 3,683 feet. In this district, Holton Gas Co. deepened No. 1 Wade H. Holton from 1,825 feet, Big Injun sand, to 1,839 feet, where there was a volume of 500,000 feet a day without a shot.

In Calhoun County, Dun Mar Oil & Gas Co. completed the test on the C. K. Weekley farm in Washington district, at 1,588 feet. Maxon sand was topped at 1,535 feet with 368,000 feet of gas before shot at 1,542-1,586 feet. In Sherman district, Gunn, Gainer & Gunn completed a gasser on the Stella Frame farm in Big Injun sand at 2,170-2,212 feet. The well made 256,000 feet of gas without a shot at 2,170-74 feet. In the same district, Veri Stewart and others completed a gas well on the G. B. Francis farm at 2,110 feet with the Big Injun sand at 2,074-99 feet and 82,000 feet of gas at 2,085-90 feet. It was not shot.

In Kanawha County, Pure Oil Co. completed No. 291, Williams Coal Co. lease, in Cabin Creek district, in the Berea sand and it gauged 879,000 feet of gas a day.

In Pleasants County, Dinsmoor & Co. completed deepening the test on the Emery Noland farm in Jefferson district at 1,846 feet, the Big Injun sand, and it is a gas well gauging 200,000 feet a day.

In Lincoln County, Leonard V. Hobbs deepened No. 2 Barrett Adkins, in Jefferson district, from 2,102 feet through the Brown shale at 3,120-3,456 feet with 40,000 feet of gas a day from the Berea and 160,000 feet a day from the Brown shale. In Sheridan district, the Guyan Gas Co. completed deepening No. 1 J. W. Jeffers at 3,045 feet. It is good for 134,400 feet of gas a day.

In Tyler County, A. O. Schrader and others drilled a test on the J. N. Jones farm in Mead district through the Big Injun sand to 2,012 feet and it was a dry hole.

In Wayne County, the Kentucky-West Virginia Gas Co. completed No. 55-W Wayne B. Ferguson in Lincoln district, at 3,006 feet. Corniferous lime was topped at 3,002 feet. It gauged 94,000 feet a day from the Brown shale at 2,423-3,002 feet. The good gas well completed by the Woodall-Jackson Gas Co. on the P. W. and Fay Sanson farm in Union district, Brown shale at 2,325-3,148 feet; Corniferous lime 3,148 feet, and an initial gauge of 2,000,000 feet with a gauge of 850,000 feet a day nine days after shot.

In Wetzel County, Null & Moorhead completed a second test on the Jackson Hostutler heirs farm in Church district at 3,283 feet with a gauge of 285,000 feet a day from the Big Injun and Fifth sands. The Pittsburgh Coal was at 983-88 feet. In Green district, Rowe Brothers completed a test on the S. H. Gadd farm in the Gordon sand at 3,005 feet and it is a gas well gauging 125,000 feet a day.

Oriskany Gas Field

Two wells were completed in the Oriskany gas field in Kanawha County. In Poca district, United Fuel Gas Co. completed No. 4806 on the Joseph W. Legg farm at 5,105 feet with the Oriskany topped at 5,075 feet; first gas 5,100 feet and a gauge of 6,981,000 feet a day. In the same district, Hays Oil & Gas Co. completed the test on the H. C. Painter farm at 5,193 feet with the Corniferous lime at 5,049 feet; Oriskany at 5,168 feet and a gauge of 4,198,000 feet a day.

Only one new location was announced and it was a test by Godfrey L. Cabot, Inc., on the Putnam Co. lease in Poca district, elevation 739.5 feet. This company is drilling a test in Washington district, Jackson County, north of the Kanawha County line on the Walker and Jones lease. It has reached 1,050 feet.

New Work

In Calhoun County, Z. N. Connelly made a location on the Amos Sturm farm, Sherman district, elevation 975 feet. In Gilmer County, C. F. Wilson will drill No. 1 Flora F. Ellyson, DeKalb district, elevation 1,115 feet. In Glenville district, Pittsburgh & West Virginia Gas Co. made a location on the Granville Collins farm, elevation 1,019 feet.

In Lincoln County, Sweetland Land & Mining Co. made a location on the Chelcy McCallister farm in Sheridan district. In Duval district, the Cameron Oil & Gas Co., made location for No. 2 George P. Alderson.

In Pleasants County, F. R. Ball made a location on the L. E. Flemings farm in McKim district, elevation 973 feet. In Grant district, O. J. Gabbert located a second test on the W. H. Walsh farm, elevation 813 feet.

In Wetzel County, the Manufacturers Light & Heat Co. will drill on the Matilda Lantz farm in Green district, elevation 1,260 feet. In Proctor district, Beren Good will drill on the F. W. and Roy C. Parsons farm, elevation 1,071 feet. Here, George P. Wasmuth has a location for a test on the F. W. Parsons farm, elevation 655 feet. In Magnolia district, Wasmuth and Callahan have a location for a test on the Haines estate, elevation 611 feet.

In Wood County, the Henderson Oil Co. has a location for No. 1-A on the Ralph Smith farm in Williams district, elevation 748 feet. In Union district, Raymond B. Hunt has the tools on the ground for a test of his own property.

North and East Texas

By
D. H. STORMONT

K.M.A. Well Shows 101 Feet of Pay; Big Well Is Expected

WICHITA FALLS, Tex., Nov. 14.—Attention in the North Texas area was centered on a deep wildcat in Montague County, which is indicating production from the 4,100-foot level. Test is Youngblood & Foree No. 1 J. E. Humphrey, J. Lenow Survey, Abstract 433, 1 mile west of the town of Nocona. Six feet of saturated sand was drilled from 4,139 to 4,145 feet and casing was cemented at about 4,150 feet. The plug will be drilled in the next few days.

Madden & Goldsmith, discoverers of the Canyon sand pool of southern Wichita County, sold their interest in the pool for $23,750 to Joe Kell and Grover C. Bullington. Tending to link the southwest outpost to the pool with the pool proper, Shappell Oil Co. topped the Canyon sand at 2,610 feet and cemented casing in their second test for the southern extension area. No dry holes have been drilled in this new and rapidly developing pool.

In the Hull-Silk area of northern Archer County, Thurman-Lipscomb No. 2 Wilson, E. Hall Survey, 1 mile north of the pool, cored through the 3,800-foot level and recovered only a slight showing of oil. The test is bottomed at 3,986 feet and operators may core slightly deeper before drilling to the 4,300-foot level.

In the K.M.A. pool, King Oil Co. No. 8 Pettit, Section 28, Block 7, H.&T.C. Survey, showed 101 feet of pay section, one of the thickest sections in the pool, from 3,697-3,798 feet. The well was drilled in under pressure and no estimates of its potential have been made, but it is expected to be one of the largest producers in the field.

Failure in Baylor

Baylor County scored another failure when H. F. Wilcox Oil & Gas Co. drilled its third dry hole on its block of 11,000 acres in the southwest corner of the county. Test was the No. 1 Fritz, David Barlow Survey, Abstract 10. The wildcat topped the Bend series at 5,180 feet and was abandoned at 5,280 feet after encountering only slight oil stains.

NORTH TEXAS COMPLETIONS

Archer County

L. T. Burns No. 15 L. F. Wilson A, 1,400-06 feet, 15 bbls. Hamilton Petroleum Co. No. 2 A. J. Ikard B, 1,155-76 feet, 10 bbls. W. B. Omohundro No. 4 Charles H. Thuman, 973-76 feet, 100 bbls.

Clay County

Bridwell Oil Co. No. 16 T. C. Thornberry, 1,078-1,103 feet, 100 bbls. M. Hudson No. 5 State Lands, 222 feet, dry. W. H. Metzner No. 11 J. J. Taylor, 1,106-24 feet, 150 bbls. Norwood and others No. 2 M. A. Stephenson, 260 feet, dry.

Cooke County

Texas Co. No. 5 Trubeonbach B, 890-900 feet, 17 bbls.

Jack County

J. V. Coffee and others No. 1 Yates, 397 feet, dry. B. C. Gilmore No. 1 Mrs. J. W. Maxey, 503 feet, dry. Hanlon-Buchanan No. 1 J. L. King, 1,364 feet, dry. McCutchin and others No. 1 J. R. and C. P. Clayton, 2,980-3,075 feet, 150 bbls. Wright & Roney No. 1 Roney, 474 feet, dry.

Wichita County

W. E. Bernard No. 2 T. O. Shappell, 859-69 feet, 7 bbls. Continental Oil Co. No. 2-B N. H. Martin, 3,801-82 feet, 352 bbls. W. H. Hammon No. 15 McCarty B, 3,740-3,906 feet, 720 bbls. King Oil Co. and others No. 11 Charles Pettit, 3,708-50 feet, 720 bbls. Melat & Graham No. 2 N. H. Martin, 3,770-3,899 feet, 575 bbls. Paul B. Scott No. 1, 2 and 3 State Lands, abandoned locations. Staley Oil Co. No. 3 J. M. McFall, abandoned location. Texas Co. No. 18 J. L. Waggoner A, 3,736-3,836 feet, 900 bbls.

Wilbarger County

C. U. Beasley No. 1 W. T. Waggoner, 3,060 feet, dry. Gibson & Jennings No. 2 D. Gfeller, 1,890 feet, dry.

Young County

Gorsuch Oil Co. No. 28 Mrs. O. W. Mathews, 695-728 feet, 20 bbls. Sparks & Hanson No. 3 G. B. Hamilton, 851-68 feet, 120 bbls. R. V. Tidwell No. 1 J. N. Ivey, 3,537-52 feet, 52 bbls. E. D. Willis No. 4 G. Stewart B, abandoned location.

EASTERN TEXAS

DALLAS, Tex., Nov. 14.—The East Texas area was featured by activity in Houston County and the new discovery in Leon County. Humble Oil & Refining Co., in carrying out its drilling campaign announced several months ago for the Houston County pool, completed another well in the Navarro Crossing area, began testing a second prospective producer, and staked location for a third test.

The Humble company No. 1 M. B. Hill gauged 115 bbls. in 24 hours from a total depth of 5,896 feet. Its No. 1-B Henery Dailey, south and west of the discovery well, set 5½-inch casing at 4,889 feet, total depth, after drilling 14 feet of gas and oil sand. No. 1 Hy Smith has been staked by the company in the Jesse G. Thompson Survey, approximately 1,200 feet south of the Sun Oil Co. No. 1 H. H. Dailey.

In Leon County, J. K. Hughes has bought out all interests in the discovery well, No. 1 Sam Bain, and is preparing to build a pipe line to the well and launch a drilling campaign in the area. The well, formerly owned by J. K. Hughes, Richards & Holloway, Tucker and others, was officially gauged at 171 bbls. of oil per day, with 114 bbls. of water.

Navarro County received a new wildcat when Wilson and associates started No. 1 Charles Healer, in the J. Latham Survey, 4 miles west of Richland. The test is shut down for repairs at 2,950 feet after topping the Woodbine sand at 2,895 feet. When the rig is repaired, operators will core the balance of the sand.

EAST TEXAS FIELD COMPLETIONS

(One-hour tests)

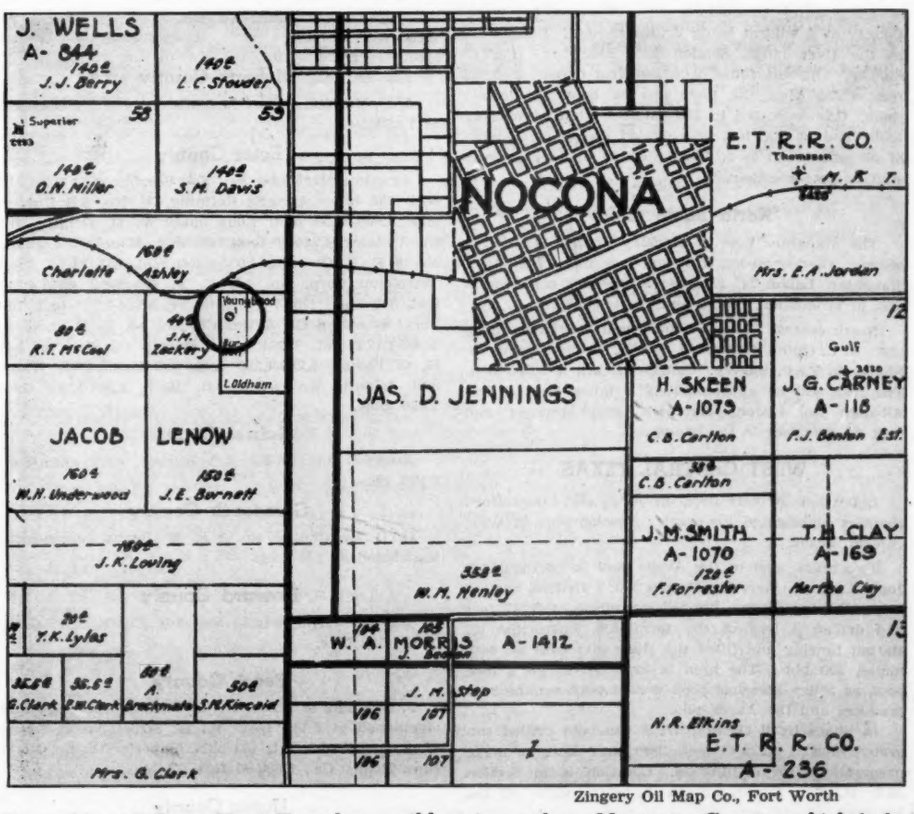
Gregg County—Longview Area

General Crude No. 4 J. G. McGrede, 3,601-31 feet, 48 bbls.; No. 5 J. G. McGrede, 3,618-20 feet, 45 bbls. Humble Oil & Refining Co. No. 11 M. Wells, 3,678-80 feet, 38 bbls. Shell Petroleum Corp. No. 12 G. Jones, 3,526-98 feet, 50 bbls.; No. 14 B. Moore, 3,526-3,605 feet, 50 bbls. Angus Spear No. 4 G. E. McCrede, 3,625-35 feet, 45 bbls.

Gregg County—Kilgore Area

Gulf Oil Corp. No. 36 C. Alexander, 3,520-31 feet, 70 bbls. C. V. Lansberry No. 9 Allison-Money, 3,593-94 feet, 30 bbls.; No. 23 Allison-Money, 30 bbls. E. B.

(Continued on Page 243)



Zingery Oil Map Co., Fort Worth

Youngblood & Foree No. 1 Humphrey, wildcat in northern Montague County, which is indicating commercial production

Promising Tests in Andrews County; Deep Tests in Pecos

By
D. H. STORMONT

FORT WORTH, Tex., Nov. 14.—Andrews and Pecos counties centered attention in the West Texas district while the possibilities of new producing areas in Jones and Shackelford counties held the interest in West Central Texas.

Three drilling wells in Andrews County indicated production possibilities and a fourth was dry and abandoned. J. W. Tripplehorn No. 1 M. A. Thornberry, indicating a half mile southeast extension to the Deep Rock area, was cleaning out at 4,345 feet with 200 feet of oil in the hole. Extending the Means pool in Andrews County a quarter mile to the southeast, Humble Oil & Refining Co. No. 51 Means, flowed 25 bbls. of oil hourly after a three-stage acid treatment at a total depth of 4,512 feet. H. C. Wheeler No. 1 White & Shelton, 4 miles west of the Means pool, is swabbing to a total depth of 4,600 feet, after having had favorable showings from 4,568 feet to total depth. Failure was registered at Fuhrman Petroleum Corp. No. 1 Ashton, Section 12, Block 42, P.S.L. Survey, 1 mile west of the Fuhrman pool. The test flowed 150 bbls. of sulfur water per day from 4,465-4,529 feet.

Deep Tests in Pecos

Deep development in the western part of Pecos County was assured when Trans-Pecos Oil Co. announced plans to deepen two wildcats. The wells are the company's No. 1 Popham Land & Cattle Co., Section 235, Block 11, G.H.&S.A. Survey, and No. 1 Gallaher, Section 9, Block 51, T.&P. Survey. They will be deepened to the Delaware sand, expected at around 5,000 feet.

Commercial production was expected in Ward County at a wildcat being drilled by J. E. Fitzpatrick in the Dyer lands, Section 135, Block 34, H.&T.C. Survey. The test found 2,000,000 feet of gas at 5,132 feet which blew the tools up the hole and lodged them. Gas decreased to 800,000 feet while recovering tools, and as the test was drilled deeper a showing of oil was found at 5,143 feet where operations were shut down for orders.

North Basin Area

The Slaughter pool of Hockley County received a setback when Snowden & McSweeney abandoned No. 1 Slaughter, Labor 74, League 75, one-half mile southeast of production. Total depth was 5,096 feet.

North central Dawson County will be given a deep test. S. L. Guinn staked No. 1 J. E. Neely, Section 28, Block 35, T.&P. Survey. Contract depth is 5,000 feet. The test will be approximately 9 miles east of Ray Albaugh No. 1 John Robinson, small pumper and first oil producer in the county.

WEST CENTRAL TEXAS

Indications of new pools in Jones and Shackelford counties highlighted the week's development in West Central Texas.

Two miles west of the Avoca pool in northeastern Jones County, Ungren & Frazier No. 1 Griffin, Section 199, B.B.B.&C. Survey, topped saturation at 3,247 feet and drilled 3 feet of the formation where the oil started flowing and filled the slush pits with an estimated 200 bbls. The area is expected to be a new pool, as a dry hole has been drilled between the new producer and the Avoca pool.

In Shackelford County, W. F. Snebold drilled saturated lime at 3,239-47 feet, then shut down to make preparations for drilling in. Location is in Section 15-3, H.&T.C. Survey, about 2 miles north of the Ivy pool.

A deep test in Haskell County, Roeser & Pendleton and Indian Territory Illuminating Oil Co. No. 1 M. O. Daughtry, has been closely watched over the past week as operators are preparing to run an electrical survey of the hole to a total depth of 4,696 feet. Only slight saturation has been reported in the upper horizons. The well is located in Wise County School Lands Survey No. 19.

Near the Taylor-Callahan County line, just inside of Callahan County, Roeser & Pendleton are moving in materials for a 5,000-foot wildcat on the Charles Yost lands, Section 18-8, S.P.R.R. Survey. Five miles to the southeast another wildcat is being drilled by J. C. Jackson and others as No. 1 T. J. Thompson, Section 30, B.B.B.&C. Survey.

This test is drilling at 1,690 feet, toward the completion of a 1,860-foot contract.

In Young County, the Tex-Tor Oil Co. is indicating a quarter mile east extension and a second well for its new pool. The test is in the Mosely Survey one-quarter of a mile east of the discovery well. The hole filled with oil after drilling to a total depth of 3,827 feet. Storage is being erected on the lease and the well is expected to rival the first drilled, which flowed 1,250 bbls. naturally in 24 hours.

WEST TEXAS COMPLETIONS

(24-hour tests)

Andrews County

Furhman Petroleum Co. No. 1 Ashton, dry and abandoned at 4,529 feet; No. 2-A Boner, abandoned location; No. 12 Ford, abandoned location.

Crane County

Magnolia Petroleum Co. No. 1-6 University, 3,170-3,250 feet, 80 bbls.

Dickens County

J. F. Morrissey No. 1 McMahon, dry and abandoned at 1,050 feet.

Ector County

American-Maricaibo No. 8-A Scarbauer, 4,162-4,210 feet, 953 bbls. Atlantic Refining Co. No. 6-B University, 3,500-3,650 feet, 1,601 bbls. W. H. Dening, Jr., No. 1 Slator, 4,240-90 feet, 165 bbls. Honolulu & Black No. 8 E. F. Cowden, 4,075-4,182 feet, 631 bbls. Shell Petroleum Corp. No. 1-B E. F. Cowden, 4,070-4,245 feet, 519 bbls.; No. 7-A Scarbauer, 4,174-4,214 feet, 700 bbls. Stanolind Oil & Gas Co. No. 9-A E. F. Cowden, 3,995-4,174 feet, 1,364 bbls. Sunray Oil Co. No. 5-D H. C. Foster, 4,210-4,235 feet, 382 bbls. Tide Water and Atlantic No. 4-C O. B. Holt, 4,206-4,363 feet, 1,750 bbls.

Gaines County

Amon G. Carter No. 2-D Wasson, 4,891-4,989 feet, 1,128 bbls.

Glasscock County

O. B. Greathouse No. 1 R. K. Burns, temporarily abandoned at 180 feet.

Howard County

Merrich-Murphy-Lamb No. 3-B Chalk, 2,885-2,949 feet, 1,522 bbls.

Pecos County

J. D. Kugle & Sunset No. 2 W. C. Jackson, dry and abandoned at 2,111 feet. W. H. Street No. 5 Texas-Shearer, 1,401-52 feet, 483 bbls. Superior Oil Co. No. 4 Iowa Realty Co., 1,630-60 feet, 78 bbls.

Upton County

Anderson & Prichard No. 3 Elder, 2,190-2,223 feet, 1,141 bbls. Basin Oil No. 5-D Baker, 2,242-2,315 feet, 1,095 bbls. Gulf Oil Corp. No. 2-C Sherk, 2,652-2,780 feet, 64 bbls. Humble Oil & Refining Co. No. 19-B Richie, abandoned location.

Scurry County

Coffield & Guthrie No. 1 Spears, 2,290-2,370 feet, 89 bbls.

Ward County

Gulf Oil Corp. No. 102 O'Brien, 2,548-2,778 feet, 272 bbls. Magnolia Petroleum Co. No. 11-46 Sealy, 3,062-69 feet, 308 bbls.

Winkler County

Humble Oil & Refining Co. No. 16-D J. B. Walton, 2,794-2,990 feet, 226 bbls.

Yoakum County

Humble Oil & Refining Co. No. 2 H. O. Wooten, 4,875-5,045 feet, 461 bbls. Shell Petroleum Corp. No. 7 H. L. Lowe, 4,868-5,155 feet, 724 bbls. Texas Co. No. 5 N. W. Willard, 4,842-5,100 feet, 398 bbls.

WEST CENTRAL TEXAS COMPLETIONS

(24-hour tests)

Brown County

South Bell No. 1 Harris Estate, dry and abandoned at 1,996 feet. George Christie No. 5 Kilgore Brothers, dry and abandoned at 565 feet. Delmarva Oil Corp. No. 1 A. D. Shields, 539-41 feet, 10 bbls. B. F. Phillips No. 1 J. Seawalt, 883-91 feet, 1,383,000 feet of gas.

Callahan County

W. H. Bundrant No. 1 Jones, dry and abandoned at 314 feet. Earl Johnson No. 2 B. E. Higgins, dry and abandoned at 443 feet. A. H. Odell No. 1 J. S. Hart, dry and abandoned at 530 feet.

Coleman County

Bob Murray No. 1 J. E. Dibrell, dry and abandoned at 2,865 feet. Simpson & White No. 1 Baker, 2,257-99 feet, 4,390,000 feet of gas.

Comanche County

Loraine No. 1 R. J. Haile, 2,524-2,781 feet, 15 bbls.

Jones County

S. G. Hodges No. 1 J. M. Wyatt, 1,620-31 feet, 10 bbls.

Shackelford County

Iron Mountain Oil Co. No. 5 O. E. Beck, 3,211-19 feet, 406 bbls.

Taylor County

Ed. C. Lawson No. 1 B. E. Bell, dry and abandoned at 2,360 feet.

Throckmorton County

Danciger Oil & Refining Co. No. 1 Brockman, 4,360-70 feet, 18 bbls.

PANHANDLE FIELD COMPLETIONS

(24-hour tests)

Carson County

Carl Smith No. 1 Percival, 2,445-2,699 feet, 70,552,000 feet of gas. United Crude "B" No. 5 Cooper A, 3,160-3,202 feet, 761 bbls.

Hutchinson County

Gulf Oil Corp. No. 81 Dial, 2,695-3,030 feet, 190 bbls. Phillips Petroleum Co. No. 35 Cockrell Ranch,

(Continued on Page 244)

Rocky Mountain Area

By T. R. INGRAM

2,400-Barrel Well and a Big Gasser in 2 Wyoming Pools

DENVER, Colo., Nov. 14.—The Continental Oil Co., California Co., and Amerada Petroleum Corp. test on Divide Creek, in Colorado, the highest and deepest drilling well in the Rocky Mountain area, was forced to shut down for the winter by snow storm.

In Wyoming, the MacKinnie Oil & Drilling Co. No. 4 Thompson, in Lance Creek, made 102 bbls. an hour from 68 feet of Leo sand. The Ohio Oil Co. No. 3-A Baker, at Oil Springs, Carbon County, is blowing wild, making 30,000,000 to 40,000,000 feet of gas and 20,000 bbls. of water. The Stanolind Oil & Gas Co. No. 8 Tensleep, in Salt Creek, is making 230 bbls. per day through a 3/32-inch choke. The Stanolind Oil & Gas Co. No. 26 Elk-2, in Elk Basin, was deepened 56 feet and recompleted for 20,000,000 feet of gas.

Montana had only one completion, a dry hole in Kevin-Sunburst. A wildcat in Judith Basin County is making 8,000 bbls. of water in a lime break in the Madison. Santa Rita Oil & Gas Co. is moving in for another test in North Cut Bank. The Montana Gas Corp. will drill another test on the Bow and Arrow structure in Toole County.

NEW MEXICO

Westmount Oil Co. No. 1 Amerada-State, C NW NE Section 12-17-36, wildcat about 6 miles south and 2 miles east of Lovington in Lea County, apparently has opened a new producing area and defined a major structural high for the area. It blew cement plug from the hole when operators were preparing to drill plug from 8⅝-inch casing, which had been set at 1,936 feet. It was not thought another cement job would be necessary, however. Gas, estimated at 10,000,000 feet daily, was being allowed to blow while the crew drilled ahead below 3,390 feet. The wildcat was running about 200 feet higher structurally on top of Yates sand at 3,050 feet, plus datum 770, than a dry hole drilled 1½ miles south and slightly east by Western Drilling & Engineering Co., thus defining a structure.

At a state lease sale held in Santa Fe last week, Skelly Oil Co. obtained a quarter-section tract slightly more than 1 mile north of the Westmount discovery. The company was reported to have paid $107 an acre for SE quarter Section 36-16-36. Stanolind Oil & Gas Co. is reported to have staked location for a north offset to the Westmount wildcat at its No. 1 State, 660 feet from the south and 1,890 feet from the east line of Section 1-17-36. Barnsdall Oil Co. has dug cellar and pits at No. 1 Humble-State, C NE SE Section 33-16-36, 3 miles to the northwest.

Only seven completions in southeastern New Mexico were reported the past week. These included five producers and a failure in Lea County and a failure in Eddy County, as follows:

Texas Co. No. 9-O State, C SE SW Section 36-17-34, Vacuum area, Lea County, topped pay at 4,316 feet, total depth 4,710 feet, and flowed 153 bbls. of oil naturally in three hours through seven-eighths inch choke on 2-inch tubing set at 4,655 feet.

Phillips Petroleum Co. No. 10 Santa Fe, C NE NW Section 24-17-34, was bottomed at 4,706 feet and flowed 98 bbls. of oil in six hours through open tubing from pay topped at 4,450 feet.

Italo Petroleum Corp. completed No. 1 Carlson A-22, SW SE SE Section 22-25-37, Langlie area, at total depth of 3,327 feet, with top of pay at 3,292 feet. It flowed 960 bbls. of oil naturally in 24 hours initial yield. Gas gauged 350,000 feet.

Twin Oil Corp. No. 1-B State, C NW NE Section 17-22-37, was bottomed at 3,710 feet, acidized with 1,000 gallons and flowed 124 bbls. of oil in 12 hours, later gauging 172 bbls. in 24 hours.

Ohio Oil Co. No. 1 Wills, C NE NW Section 35-26-37, was completed for 30 bbls. of oil daily from pay topped at 3,100 feet, total depth 3,300 feet. Volume of gas was 1,000,000 feet.

Texas Co. No. 1 Lodewick, C SW SE Section 34-18-33, Lea County wildcat, had a slight showing of dead oil at 4,260-80 feet, but was dry and abandoned at 4,295 feet, total depth.

In Eddy County, Martin & Lysette No. 1 Pardue & Guitar, SE SW NW Section 29-24-26, wildcat, had a hole full of water and was dry and abandoned at 1,875 feet, total depth. Payton Brothers No. 1 Erwin, C SW SW Section 9-18-31, location, was reported temporarily abandoned.

Lea County

Amerada Pet. Co. No. 1 Johnson, C NW SW Sec. 27-24-37. Drlg. 3,230 ft.
Amerada Pet. Co. No. 5-VA State, C NW NW Sec. 22-17-35. Drlg. 4,000 ft.
Aloco Oil Co. No. 1 Carson, C SW SE Sec. 28-21-37. T.D. 815 ft.; U.R.
Anderson & Prichard No. 4 Carlson-Harrison, NE SE NE Sec. 27-25-37. T.D. 3,349 ft.; S.O.
Anderson & Prichard No. 3 Stuart, C NW NW Sec. 9-25-37. T.D. 3,499 ft.; tstd. 60 B.O.P.D. nat.
Anderson & Prichard No. 4 Wells, C NW NW Sec. 5-25-37. W.O.C. 1,210 ft.
Cities Service No. 1-L State, C SE SW Sec. 15-17-35. Fsg. at 3,600 ft.
J. C. Clower No. 1-B Manda, NE NE NW Sec. 28-22-37. Prep. to spud.
Continental Oil Co. No. 3 Britt B-15, C W½ NW SW Sec. 15-20-37. Drlg. 3,662 ft.
Continental Oil Co. No. 1 Hawk B-6, NW NW SE Sec. 6-21-37. Rng. csg. 260 ft.
Continental Oil Co. No. 1 Howe A-5, C SW NE Sec. 5-21-38. Drlg. 3,094 ft.
Continental Oil Co. No. 1 Lockhart, B-13, NW NW NW Sec. 13-21-36. Drlg. plug. at 3,770 ft.
Continental Oil Co. No. 2 Lockhart B-1, C SE NW Sec. 1-22-36. T.D. 3,731 ft.; W.O.C.
Continental Oil Co. No. 4 Lockhart B-31, S½ SE SE Sec. 31-21-36. T.D. 3,550 ft.; rng. squeeze job.
Continental Oil Co. No. 2 Meyer B-31, C NE SW Sec. 31-20-38. Drlg. 1,090 ft.
Continental Oil Co. No. 4 Meyer B-18, C E½ SE NW Sec. 18-21-36. Drlg. 3,828 ft.
Continental Oil Co. No. 8 Reed B-23, CEL SW NE Sec. 23-20-36, C.&P.
Continental Oil Co. No. 1 State 1-7, NE NW NE Sec. 7-17-34. T.D. 4,895 ft.; C.O. at 4,727 ft.
Continental Oil Co. No. 2 State A-36, NE SE Sec. 36-20-36. Drlg. 1,000 ft.
Continental Oil Co. No. 2 State C-16, SW SW NW Sec. 16-20-37. Drlg. 80 ft.
Continental Oil Co. No. 3 State H-35, C SW NW NE Sec. 35-17-34. Drlg. 400 ft.
Continental Oil Co. No. 3 State J-2, C SE NE Sec. 2-22-36. Drlg. 2,915 ft.
Culbertson & Irwin No. 2 Dabbs, NE NW NW Sec. 35-25-37. Drlg. 3,265 ft.; F. by heads.
Devonian Oil Co. No. 2 Christmas, SE SW SE Sec. 28-22-37. Loc.
Devonian Oil Co. No. 1 State-Ritts, C NW NW Sec. 21-17-34. Drlg. 3,835 ft.
Walter Donnelly No. 1 Davis, C SE NW Sec. 33-23-37. T.D. 3,600 ft.; C.O.
Great Western Prod. No. 1 Leonard, C SE NE Sec. 32-23-37. O.W.D.D.; O.T.D. 3,615 ft.; T.D. 3,669 ft.; rng. tbg.
Great Western Prod. No. 2-B Leonard, C NW NW Sec. 32-23-37. Loc.
Gulf Oil Corp. No. 1 Alley, C NE SE Sec. 10-23-37. T.D. 3,715 ft.; to tst.
Gulf Oil Corp. No. 3-D Arnott-Ramsey, C NE NE Sec. 33-21-36. T.D. 3,885 ft.; F. 66 B.F. in 1 hr.; 66 per cent wtr.
Gulf Oil Corp. No. 1 Holt, C SW SE Sec. 16-24-37. T.D. 3,548 ft.; P.B. 3,475 ft.; shot and C.O.
Gulf Oil Corp. No. 1-F Mattern, C NW NE Sec. 1-22-36. Drlg. 2,515 ft.
Helmerich & Payne and Continental Oil Co. No. 1-G-36 State, C NW SW Sec. 36-17-35. T.D. 4,950 ft.; S.I., no tsts.
Humble O. & R. Co., No. 4-H State, C NE NW Sec. 34-22-37. W.O.C. 3,405 ft.
Italo Pet. Corp. No. 2 Carlson A-22, NE SW SE Sec. 22-25-37. T.D. 3,354 ft., sd.; F. 50 B.O.P.H. for 5 hrs. S.I. storage.
Italo Pet. Corp. No. 1 Carlson A-23, NW NW SW Sec. 23-25-37. Drk.
Italo Pet. Corp. No. 1 Carlson B-27, NE NW NE Sec. 27-25-37. Drlg. 800 ft.
Italo Pet. Corp. No. 2 Carlson B-27, NE NE SE Sec. 27-25-37. R.U.R.
Italo Pet. Corp. No. 1 Indian Pet. Corp., NE NE NE Sec. 6-25-37. Drk.
Magnolia Pet. Co. No. 2 Hardy, NW NW NW Sec. 29-21-37. T.D. 3,820 ft.; C.O. at 3,704 ft.
Magnolia Pet. Co. No. 3 Hardy, C NE NW Sec. 29-21-37. W.O.C. 3,670 ft.
Magnolia Pet. Co. No. 1-N State, C SW NW Sec. 19-17-35. T.D. 4,780 ft.; tstg.
Magnolia Pet. Co. No. 2-M State, NW NW Sec. 34-17-35. Drlg. 1,598 ft.
Magnolia Pet. Co. No. 17 State-Bridges, C NE NE Sec. 25-17-34. T.D. 4,750 ft.; est. 100 B.O.P.D.
Magnolia Pet. Co. No. 18 State-Bridges, C SE NW Sec. 24-17-34. Drlg. 3,980 ft.
Magnolia Pet. Co. No. 19 State-Bridges, C NW NW Sec. 24-17-34. Drlg. 3,245 ft.
Maljamar O. & G. Co. No. 1-B Baish, C NE NW Sec. 22-17-32. T.D. 3,600 ft.; R.U.S.T.
Maljamar O. & G. Co. No. 6 Mitchell, C SW NE Sec. 20-17-32. Drlg. 100 ft.
Maljamar O. & G. Co. No. 1-B State, C SW SE Sec. 16-17-32. T.D. 4,125 ft.; S.I.
Jas. A. Mascho No. 2 Cloyd, C SW SW Sec. 20-22-33. T.D. 5,038 ft.; S.D.O.
J. M. Murray, Trustee, No. 1 Fanning, SE SW NW Sec. 33-23-37. S.D.O. 3,434 ft.
Ohio Oil Co. No. 2 Sanders, NW NW Sec. 1-22-36. R.U.R.
Ohio Oil Co. No. 1 State-Shugart, C NE SE Sec. 34-17-34. Drlg. 4,018.
Ohio Oil Co. No. 2 State-Warn, C NE NW Sec. 6-18-35. Drlg. 4,621 ft.
Olean Pet. Co. No. 1 Brunson, SW SE SE Sec. 4-22-37. Drlg. 3,510 ft.
Olean Pet. Co. No. 2 Brunson, SW NE SE Sec. 4-22-37. Drlg. 675 ft.
Olean Pet. Co. No. 1 Farrell, C NE SE Sec. 22-22-37. T.D. 3,684 ft.; P.B. 3,664 ft.; F. 36 B.O. in 24 hrs.
Parker Drlg. Co. No. 3 Erwin, C W½ NE SW Sec. 35-24-37. Drlg. 50 ft.
Lem Peters No. 3 L. J. May, C NE SE Sec. 27-22-37. Drlg. 2,320 ft.
Lem Peters No. 2 T. O. May, NW NE NE Sec. 34-22-37. S.D. repairs 3,435 ft.
Phillips Pet. Co. No. 2 Hale, C NE SW Sec. 35-17-34. Drlg. 2,845 ft.
Phillips Pet. Co. No. 3 Hale, C SE SE Sec. 35-17-34. Drlg. 1,175 ft.
Phillips Pet. Co. No. 1 Mabel, C SW NW Sec. 35-17-34. Rng. csg. 4,185 ft.
Phillips Pet. Co. No. 12 Santa Fe, C NE SW Sec. 28-17-35. Drk.
Phillips Pet. Co. No. 13 Santa Fe, C NW NW, Sec. 28-17-35. Drk.
Phillips Pet. Co. No. 14 Santa Fe, C SE SE Sec. 20-17-35. Drk.
Phillips Pet. Co. No. 15 Santa Fe, C NE NE Sec. 28-17-35. Drlg. 1,405 ft.
Phillips Pet. Co. No. 16 Santa Fe, C NW SW Sec. 5-18-35. R.U.R.
Phillips Pet. Co. No. 17 Santa Fe, C SE SW Sec. 28-17-35. R.U.R.
Schermerhorn Oil Co. No. 3 Woolworth, NW NW SE Sec. 28-24-37. Drlg. 2,920 ft.
Shasta Oil Co. No. 3 Woolworth, NE SE NW Sec. 28-24-37. Drlg. 2,520 ft.
Shell Pet. Corp. No. 3 Grizzel, C SE SE Sec. 8-22-37. Drlg. 3,695 ft.
Shell Pet. Corp. No. 2-F State, C SE SW Sec. 29-17-35. R.U.R.
Shell Pet. Corp. No. 1-H State, C NW SW Sec. 29-17-35. T.D. 4,700 ft.; shot and C.O.
Shell Oil Corp. No. 1-I State, C SW NW Sec. 29-17-35. T.D. 4,753 ft.; shot and C.O.; no tests.
Shell Pet. Corp. No. 1-N State, NE NE SE Sec. 24-21-35. T.D. 3,946 ft.; F. 19 B.F. in 9 hrs.
Shell Pet. Corp. No. 1-N State, C NW NE Sec. 28-17-35. Drlg. 1,035 ft.
Shell Pet. Corp. No. 1-O State, C SE NE Sec. 34-17-34. W.O.C. 4,390 ft.
Shell Pet. Corp. No. 1-S State, C NE SE Sec. 21-17-35. T.D. 4,745 ft.; swb. 37 B.O. in 15 hrs.
Shell Pet. Corp. No. 2-B State, C NE SE Sec. 30-17-35. Rng. csg. 1,630 ft.
Shell Pet. Corp. No. 1-V State, C NE SE Sec. 27-17-35. R.U.R.
Skelly Oil Co. No. 1 Baker, C SW SW Sec. 10-22-37. T.D. 3,752 ft.; F. 24 B.O.P.D.; to acdz.
Skelly Oil Co. No. 2 Baker, C NW NW Sec. 27-22-37. (O.W.D.D.) T.D. 3,714 ft.; P.B. 3,706 ft.; shot.
Skelly Oil Co. No. 1-B King, C NE SW Sec. 33-22-37. T.D. 3,710 ft.; F. 82 B.O. in 2 hrs. and died.
Stanolind O. & G. Co. No. 4-C Hill, C SE NW Sec. 5-21-37. Drlg. 3,680 ft.
Skelly Oil Co. No. 4 Simms, C NW NW Sec. 3-23-37. Drlg. 1,707.
Standard Oil Co. of Texas No. 1 State, Lease 5, C NW NW Sec. 27-17-35. T.D. 4,654 ft.; F. 87 B.O. in 10 hrs. and died.
Standard Oil Co. of Texas No. 2 State, Lease 4, C SW SE Sec. 27-17-35. Drlg. 3,540 ft.
Standard Oil Co. No. 2 State, Lease 5, C SE NW Sec. 27-17-35. C.&P.
Texas Co. No. 4 Black, C SE NW Sec. 21-24-37. Drlg. 2,978 ft.
Texas Co. No. 1-T State, C SE NE Sec. 25-17-34. T.D. 4,725 ft.; C.O. at 4,565 ft.
Texas Co. No. 2-L State, C NE NE Sec. 1-18-34. T.D. 4,100 ft.; drlg. plug.
Texas Co. No. 2-N State, C NW SW Sec. 30-17-35. T.D. 4,720 ft.; swb. 4 B.O.P.H.
Texas Co. No. 3-R State, C SE NE Sec. 6-18-35. Loc.
Texas Co. No. 1-U State, C NE NE Sec. 2-18-34. Drlg. 4,125 ft.
Texas Co. No. 1-V State, C NE NW Sec. 34-17-34. Drlg. 4,453 ft.
Texas Co. No. 1-W State, C SW SE Sec. 13-17-34. Drlg. 4,292 ft.
Texas Pacific Coal & Oil Co. No. 7-A State, NW NW NW, Sec. 32-23-36. Drlg. 2,115 ft.
Twin Oil Co. No. 1 Hare, C SE SW Sec. 33-21-37. Drlg. 3,596 ft.
Twin Oil Co. No. 2 Hare, C NW SW Sec. 33-21-37. Rng. tbg. at 3,515 ft.

Twin Oil Co. No. 2 State, C SW NW Sec. 32-21-37. Drk.
Weier Drlg. Co. No. 2 Woolworth, NE SE SW Sec. 28-24-37. T.D. 1,440 ft.; W.O.C.
Sam Weiner No. 3 Smith, C N½ NE SE Sec. 4-25-37. Drlg. 1,708 ft.
Sam Weiner No. 1 Woolworth, SE NE SW Sec. 33-24-37. W.O.C. 3,316 ft.
Westmount Oil Co. No. 1 Amerada, C NW NE Sec. 12-17-36. T.D. 3,327 ft.; est. 10,000,000 ft. gas.
Westmount Oil Co. No. 1 State, C SE NW Sec. 30-17-35. T.D. 4,728 ft.; F. 37 B.O. in 24 hrs.
Francis C. Wilson No. 2 State, C NW NE Sec. 7-21-35. Drlg. 2,450 ft.

Eddy County

Adkinson Oil Co. No. 1 Brainard, SE SW SE Sec. 5-18-27. S.D.O. 625 ft.
F. E. Baker No. 1 Eddy, NE Sec. 12-22-27. T.D. 2,765 ft.; fsg.
George E. Robb No. 1 Cannon, NE SW SE Sec. 4-19-30. C.&P.
George E. Robb No. 1 Vandagriff, SW NE Sec. 6-19-31. Drlg. 60 ft.
Carper Drlg. Co. No. 1 Day, NE NE NE Sec. 3-19-21. T.D. 2,748 ft.; P.B. 2,693 ft.; wtr. shut off; tstg.
Carper Drlg. Co. No. 3 Robinson, SW SW SE Sec. 25-16-31. T.D. 3,550 ft.; est. 6,000,000 ft. gas.
B. Cockburn No. 1 State, C SW NE Sec. 16-18-31. Drlg. 3,294 ft.; 650 ft. O.I.H.
Danciger O. & R. Co. No. 1-B Turner, CEL NE SE Sec. 17-17-31. Drlg. 3,359 ft.
Dominion O. & G. Co. No. 2 Johnson, C SE NE Sec. 35-16-31. T.D. 4,033 ft.; F. 30 B.O. in 3 hrs. and died.
Dominion O. & G. Co. No. 3 Johnson, C NE SW Sec. 35-16-31. T.D. 3,950 ft.; swb. 55 B.O. in 24 hrs.
English & Harmon No. 1 Dougherty, NE NE SW Sec. 3-17-27. T.D. 2,319 ft.; gauged 1,000,000 ft. gas; S.I.
English & Harmon No. 1 Stogner, C NW SE Sec. 31-17-31. Mch.
Etz Bros. No. 5 State, SE NE SE Sec. 16-17-30. S.D. reprs. 2,280 ft.
Farmer & Tallmadge No. 1 Hubell, NE SW Sec. 4-18-25. Rng. csg. 180 ft.
Franklin Pet. Corp. No. 1 McIntyre, NW NE SE Sec. 20-17-38. T.D. 3,348 ft.; C.O. on bttm., re-rng. tbg.
Fullerton Oil Co. No. 3-A Johnson, C NW SW Sec. 35-16-31. Drlg. 3,322. ft.
C. F. Ingram No. 1 Page, NE NE SW Sec. 15-21-28. T.D. 2,844 ft.; S.D., reprs.
New Mexico Eastern Gas Co. No. 2 Stephens, SE SE NE Sec. 20-17-38. Drlg. 1,750 ft.
Paton Bros. No. 1 Erwin, C SE SE Sec. 5-18-31. Mch.
Premier Pet. Co. No. 1 Maddren-Beeson, NE SW SE Sec. 28-17-30. T.D. 3,418 ft.; pump. est. 8 B.O.P.D.
Premier Pet. Corp. No. 2-B Beeson, SW NW SW Sec. 27-17-30. Drlg. 2,920 ft.
Worth Drlg. Co. No. 1 Taylor, C SW SW Sec. 12-18-31. Drlg. 3,235 ft.
Martin Yates, Jr., No. 1 Bowers, SW SE SE Sec. 31-19-27. T.D. 1,180 ft.; S.D.O.
Yates et al No. 1 Yates, C NW SW Sec. 6-18-30. Drlg. 1,622 ft.

Chaves County

E. J. Fisher No. 1 Foster, C NW NW Sec. 7-15-26. T.D. 1,281 ft.; S.D.O.
Nav Hightower No. 1 Billingslea, C SW NE Sec. 28-11-30. T.D. 770 ft.; S.D. for csg.
Interstate Minerals, Inc., No. 1 Dunigan, NW cor. Sec. 15-15-30. T.D. 3,982 ft.; S.D.O.
J. & L. Drlg. Co. No. 2 Hurd, SW Sec. 11-11-26. Drlg. 1,800 ft.

De Baca County

N. F. Woods No. 1 Jones, C NE SW Sec. 17-4n-20. T.D. 190 ft.; S.D.O.
James D. Ward No. 1 Summers, SE NE SW Sec. 15-4n-24e. T.D. 680 ft.; S.D.O.

Roosevelt County

Shell Pet. Corp. No. 1 Harwood, C S½ SE SE Sec. 27-7s-35e. Drlg. 3,940 ft.

NORTHWEST NEW MEXICO

Bernalillo County

Norins Realty Co., Inc., No. 2 Pajarito, Sec. 22-9n-1e. Drlg. below 700 ft.
Norins Realty Co., Inc., No. 2 North Albuquerque, NE SE NW Sec. 10-11n-4e. Drlg. 4,400 ft.

McKinley County

Pet. Products Corp. No. 5 Santa Fe, SW NE NW Sec. 1-17n-9w. Drlg. 1,300 ft.
S. Dysart No. 3-A Govt., NE NW NE Sec. 14-14n-10w. Landed 12½-in. at 1,320 ft.; will cmt.

Rio Arriba County

Oil City Pet. Co. No. 1 Azotea, SW SW NE Sec. 11-31n-2e. Drlg. 333 ft. and U.R. 6¼-in.; through Greenhorn; S.O.&G.

San Juan County

Continental Oil Co. No. 83 Rattlesnake, SE SW NW Sec. 1-29n-19w. Drlg. 823 ft.
Jack Amenda No. 1, NE NE Sec. 14-29n-13w. Drlg. 530 ft.; 6⅝-in. 495 ft.
Al Greer No. 2 fee, SW SE SW Sec. 10-30-11w. Drlg. 745 ft.
Anna Oil Corp. No. 6 Govt., SW NE NE Sec. 33-30n-11w. S.D. 1,885 ft.; W.O. csg.; S.O. in Farmington sd. but will D.D. to Picture Cliff.
Goodrun & Vincent No. 2 Hare, SE SE Sec. 23-29n-11w. Drlg. 1,699 ft.; 5⅛-in. 1,500 ft.
Goodrun & Vincent No. 1 Seitzinger, NE NW SE Sec. 23-29n-11w. Drlg. 400 ft.
Ted Whetstine No. 1 McGee, NW NW Sec. 20-30n-11w. S.D. 434 ft. for mat.
Bullock & Noland No. 1 Bunce, SW SE Sec. 24-29n-11w. Drlg. 1,023 ft.
San Juan O. & G. Co. No. 1 Cassidy, C SE SE Sec. 19-29n-11w. Drlg. 820 ft.

San Miguel County

Southwest Drlg., Inc., No. 1 Conchas, NW NE Sec. 34-17n-21e. T.D. 1,450 ft.; prep. run 13⅜-in. for W.S.O.

Socorro County

Central New Mexico Oil Co. No. 1, Belen gr., SE NW Sec. 16-3n-1e. S.D. 2,965 ft. after rng. 12½-in.

Torrance County

Drice Co. No. 1 Garland, NE SE NE Sec. 32-7n-7e. S.D.O.; H.F.W. at 1,405-13 ft.
Estancia Valley Carbon-Dioxide Dev. Co. No. 1 Crawford, SE NE NE Sec. 32-7n-7e. Drlg. 1,080 ft.
Chief O. & G. Co. No. 1 Lee, NW NW SW Sec. 12-6n-7e. T.D. 2,215 ft.; C.O. 300 ft.

Valencia County

Old Spanish Grants, Inc., No. 1 San Clemente, C SE SW Sec. 23-7n-1e. Drk.; W.O. rotary.
C. A. Grober et al No. 1 Fuqua, NE NE Sec. 19-5n-3e. T.D. 840 ft. (C.D.); W.O. title adj.

COLORADO

Adams County

J. B. Furstenberg et al No. 1 Hills, SE SE SE Sec. 27-3s-64w. S.D. 4,370 ft.

Archuleta County

Boone Dev. Co. No. 1 Newton, SE NW SE Sec. 18-33n-1e. T.D. 303 ft.; W.O. 10-in.
Pagosa Oil & Dev. Co. No. 1 Macht, C Sec. 32-36-1w. T.D. 1,840 ft.; rmg. 6¼-in. with bttm. hole pkr. to top Dakota.

Elbert County

The Plymouth Oil Co. important wildcat in the Ramah district was delayed the past week by frozen water lines. The water is brought 3 miles through line laid on the surface. Hole has been reamed to 11 inches to 6,790 feet and is drilling ahead. It is reported close to the top of the first objective, the Dakota sand.

Plymouth Oil Co. No. 1 Brosky-Union Pacific, C SW SW Sec. 19-10s-60w. Drlg. below 6,800 ft.

Fremont County

Stanley Thomas No. 1 Rickwalt, SE SE Sec. 2-19s-70w. Drlg. 2,450 ft.
R. E. Hawks No. 1 Orndoff, NE SW NE Sec. 3-19s-70w. T.D. 1,988 ft.; tstg. S.O.

Garfield County

Roaring Fork Oil Co. No. 1 Patterson, C NE Sec. 36-7s-88w. S.D. 1,767 ft.; M.I. 4¾-in.

LaPlata County

N. Spatter No. 1-X Bryce, SE SW SW Sec. 31-33n-9w. Drlg. 2,180 ft.; S.G. 2,140 ft.

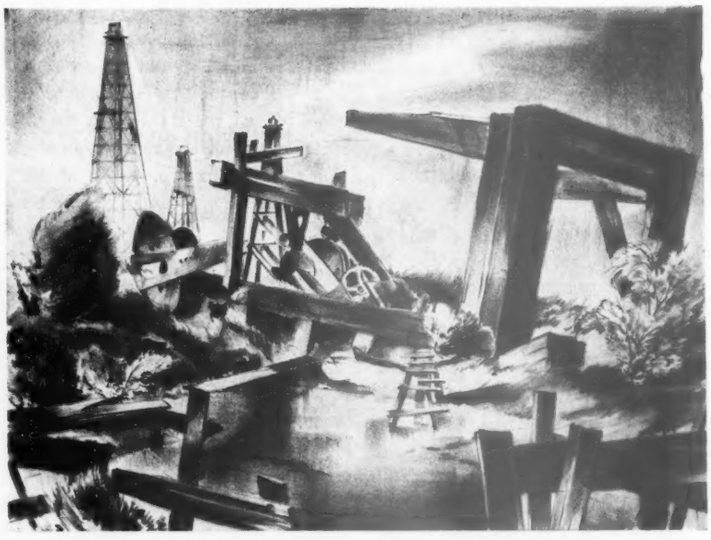
Las Animas County

Hulme-Johnston-Allison No. 1 Azar, SE SE NW Sec. 27-34s-58w. Drlg. 665 ft.

Mesa County

The joint test of the Continental Oil Co., Amerada Petroleum Corp., and the California Co. on Divide Creek is shut down at 9,410 feet for the winter. Roads have become blocked by snow. The test is in high altitude, the elevation of the well being 9,395 feet, or nearly 2 miles above sea level. At present depth it is believed to be in the Benton shales.

Continental Oil Co. et al No. 1 Miller, SW SW NW Sec. 36-8s-91w. S.D. 9,410 ft. for winter.



In the path of the 1932 Hurricane, Pierce Junction Field *from a lithograph by E. M. Schiwetz*

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Moffat County

The Stanolind Oil & Gas Co. is continuing the deepening of Sundance sand wells on the Iles dome through that horizon. Earlier completions were mostly in the upper part of the pay. Its No. 35-SD Parkinson, SE SE NE Section 22-4n-92w, is rigging up to deepen from 3,381 feet where it was completed in 1935 for 1,440 bbls. the first 24 hours through the tubing from sand at 3,371-81 feet.

Stanolind O. & G. Co. No. 35-SD Parkinson, SE SE NE Sec. 22-4n-92w. T.D. 3,381 ft.; O.W.D.D.; R.U.
Isenberg-Parker-Myers No. 1 Myers-State, NW SE NE Sec. 36-4n-103w. T.D. 50 ft.; prep. to run and cmt. 12½-in.
C. R. Provett No. 1 Sutton, NE NE SW Sec. 1-5n-96w. S.D. 860 ft. for 8¼-in.
MacKinnie Oil & Drlg. Co. No. 1 Coles, SW SW SE Sec. 1-3n-92w. Drlg. 3,050 ft.

Montezuma County

McElmo Oil Co. No. 1 West, NE NW NW Sec. 31-36s-17w. Drlg. 4,815 ft.

Park County

South Park Oil Co. No. 1 Lemar, NE NE SE Sec. 34-11s-75w. Drlg. sdy. sh. 6,435 ft.; S.O.&G.

Prowers County

Continental Oil Co. No. 1 Ruby, C NE NW Sec. 31-21s-44w. S.D. 5,434 ft.

Pueblo County

C. E. Puckett No. 1 Barber, NW Sec. 35-21s-66w. Drlg. 810 ft.
Eden O. & G. Co. No. 1 Horse Creek, SW SE Sec. 29-19s-64w. Drlg. 1,870 ft.

Rio Blanco County

Buford Oil Co. No. 1 Govt., C SW SW Sec. 16-1n-91w. S.D. 3,448 ft.; M.I. new cable.

Routt County

L. C. Craig and E. L. Moore No. 1-X Erwin, C SW NE Sec. 33-7n-85w. S.D. 160 ft.
Mid-Colorado Pet. Co. No. 1 Omholt, NE NE SE Sec. 29-4n-87w. S.D. 2,140 ft.; W.O. 6¼-in.
Steamboat Springs Drlg. Synd. No. 1 Brown, C NW NW Sec. 1-6n-86w. Cmtd. 8¼-in. 1,389 ft. in Morrison; S.D.

WYOMING

Big Horn County

Yale Pet. Co. No. 2 Allen, Lot 52 (approx. SW NW SW Sec. 34-56n-97w). Drlg. 2,330 ft.
Kirk Oil Co. No. 1 Frisby, C SW SE Sec. 11-49n-94w. Drlg. 731 ft.
A. L. Rankin No. 1 Karjajla-Rankin, C SW NW Sec. 10-54n-94w. Drlg. 588 ft.
Prescott & Mileski No. 1 Govt., NE NW SW Sec. 15-1n-93w. S.D. 875 ft.; C.D.
Clifford S. Johnson No. 1 Johnson, CEL NW NW Sec. 24-51n-93w. Rig; W.O. engine.
Joan Oil Co. No. 1 Howell, NE NW NE Sec. 32-55n-97w. T.D. 2,470 ft.; str. crkd. hole.
John H. Thomas No. 1 Govt., SW SW SE Sec. 3-54n-94w. Drlg. 920 ft.

Campbell County

Frye & Kreiner No. 2, CSL NW NW Sec. 6-50n-72w. Landed 5⅛-in. on bttm. at 723 ft. and S.D.

Carbon County

The Ohio Oil Co. No. 3-A Baker, on the Oil Springs dome, had a gas blowout at 1,786 feet, estimated at 30,000,000 to 40,000,000 feet a day, with 20,000 bbls. of water. The operator is trying to kill the well and will then attempt to shut off water. Location is 400 feet north of No. 2-A Baker, an edge well which had gas in the top of the Sundance, followed by water. Plans were made to drill a directional hole to tap the pay higher on structure, but these were abandoned in favor of a new hole from the top.

The Ohio Oil Co.-California Co. No. 5-A Kyle, on the west side of the Big Medicine Bow field, had the top of Sundance at 5,619 feet and at 5,639 feet made a Halliburton test with the tester seated at 5,622 feet. It showed oil and mud. It is drilling ahead. It is a south offset to No. 3-A Kyle, which was carried to the granite and plugged back and recompleted as a small well in the upper Sundance, and a northwest offset to No. 2-A Kyle, a producer in the upper Sundance. Log shows that No. 5-A Kyle is checking 41 feet lower on the Sundance than its north offset and 13 feet lower than the southeast offset. Above the Muddy sand it checked slightly higher than the offsets, indicating a thickening of the lower beds.

Sinclair-Wyo. Oil Co. No. 4 Mahoney, CNL NE SW Sec. 34-28n-88w. Drlg. 1,738 ft.
Ohio Oil Co. No. 3-A Baker, SW NW SW Sec. 3-23n-79w. T.D. 1,786 ft.; trying to kill gas blowout.
C. D. Cunningham et al No. 1 Union Pacific-fee, NW SE NE Sec. 21-22n-78w. Drlg. blk. sh. 1,010 ft.
Ohio Oil Co.-California Co. No. 5-A Kyle, C NW NE Sec. 26-21n-79w. Cg. below 5,639 ft.
Producers Oil Co. No. 1 Lake Valley, 200 ft. CNL Sec. 14-20n-88w. T.D. 1,916 ft.; prep. to run 10-in.

Converse County

A group of Casper men headed by Charles Wheeler are drilling a test on a high southwest of Douglas on what has been named the Crooked Stick anticline, in the NW Section 19-31n-71w. It is a little more than 2 miles west of a well drilled in 1933 by James A. Brady and others in the NW NE Section 17, which started in the Chugwater red beds and was abandoned in the granite at 1,210 feet. The new test will go to the Madison. The top of the Embar is expected at 500 feet.

Chas. Wheeler et al No. 1 Fitzhugh, NW Sec. 19-31n-71w. Drlg. r.b. 200 ft.; 10-in. on bttm.; (first report).
H. O. Emery et al No. 2 Roberts, C SW SE Sec. 2-31n-70w. Drlg. 254 ft.; S.G.
Jack Decker et al No. 1 Simonson, NW NE SE Sec. 16-32n-68w. S.D. 640 ft. for csg.
Wyshawn Oil Co. No. 2 Lindley, C SW SW Sec. 35-32n-69w. T.D. 2,390 ft.; rmg. 10-in. from 1,760 ft. to bttm.
Fred Bunker No. 1 Pestal, SE NE NE Sec. 32-32n-69w. T.D. 483 ft.; prep. to run csg.
New Era Fuel Co. No. 2 Mary Gasper, CNL NW SW Sec. 25-32n-69w. S.D. 670 ft. without tstg.
Wyshawn Oil Co. No. 1 Lindley, NW SE SE Sec. 34-32n-69w. Drlg. 2,500 ft. in Leo sd.; S.O.&G. in hd. sd. at top.
Wyo.-Southern Oil Co. No. 1 Winda, SW NE NW Sec. 6-31n-69w. Loc.
Blue Ridge Oil Co. No. 1, SW NW SE Sec. 29-32n-69w. Spd. and S.D.

Fremont County

Frank Pouppirt No. 1 Fidelity, Tr., SW NE SW Sec. 27-3n-1w. Drlg. gr. sh. 1,700 ft.
Yellowstone Oil Co. No. 1 Govt., SW NE NW Sec. 27-38n-93w. S.D. 740 ft.; boiler moved away.
Lincoln O. & G. Co. No. 26 Tribal, NE SE SW Sec. 23-1s-1e. Drlg. 690 ft.
Tropic Oil Co. No. 1 Govt., C SE SW Sec. 34-27n-90w. S.D. 3,430 ft.
Consolidated Oil Properties No. 3 Ewart, C SW SE Sec. 16-1n-1w. S.D. 1,150 ft.
Ben Stewart No. 1 Darnell, NE SE Sec. 26-3n-1w. S.D. 2,245 ft. for 7-in.
C. E. Nelson No. 8 fee, CWL NE SW Sec. 27-3n-1w. Drlg. 860 ft.

Hot Springs County

Italo Pet. Co. No. 1 Skelton-Govt., SE SW NE Sec. 13-44n-98w. T.D. 1,800 ft.; recmtd. 10-in. 1,750 ft.

Lincoln County

H. C. Harris et al No. 1 Govt., SE NW NW Sec. 23-21n-117w. S.D. 960 ft.

Natrona County

The Stanolind Oil & Gas Co. No. 8 T. P.-Midwest Oil, C NW SW Section 35-40n-79w, Salt Creek, was completed for 230 bbls. per day through a 3/32-inch choke on the 2-inch tubing from the Tensleep at 4,005 feet, total depth. The 5½-inch was cemented at 3,999 feet and perforated opposite the pay.

General Pet. Corp. No. 1 State, NW NE SE Sec. 16-35n-77w. Drlg. Niobrara sh. 6,387 ft.
Stanolind O. & G. Co. No. 29 Tensleep, C SW NW Sec. 35-40n-79w. Cg. 3,939 ft.

(Continued on Page 240)

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California Field Report

By
L. P. STOCKMAN

Coles Levee and Tupman Are New Kern County Prospects

LOS ANGELES, Calif., Nov. 14. — With three oil fields discovered in California in the first 10 months of the year present indications point to the possible discovery of two additional fields before 1938 draws to a close. The three new fields actually proved productive are the Wasco field in Kern County, Southeast Coalinga field in Fresno County and the Aliso Canyon field in Los Angeles County. The two areas that show promise of resulting in additional discoveries are Coles Levee and the Tupman area of Kern County. In the Coles Levee district, Ohio Oil Co. will test No. 1-F Kern County Land in Section 10-31-25 after having cored 145 feet of oil sand and shale. This wildcat is bottomed at 9,365 feet and has a 7-inch water string landed on top of the pay at 9,220 feet. The zone cored is believed to be the equivalent of the Stevens, which has been highly productive in the Ten Section, Greeley, Canal and other similar fields in the San Joaquin Basin. In the Tupman area, east of the Elk Hills field, Richfield Oil Corp. cored some promising oil sand in No. 1 Western-Kern County Land in Section 32-20-25. This wildcat is bottomed at 8,523 feet and plans are already under way to cement a 7-inch water string. On a formation test, open 40 minutes, with the tester at 8,245-498 feet fluid rose to the surface in 10 minutes followed by gas for 12 minutes, gas and muddy water for 8 minutes and natural gas and gasoline condensate for the remaining 10 minutes. Gas volume was at the rate of 7,000,000 feet daily, and upon pulling the tester a recovery of 160 feet of 53-gravity oil was effected.

Rio Vista Gas Field

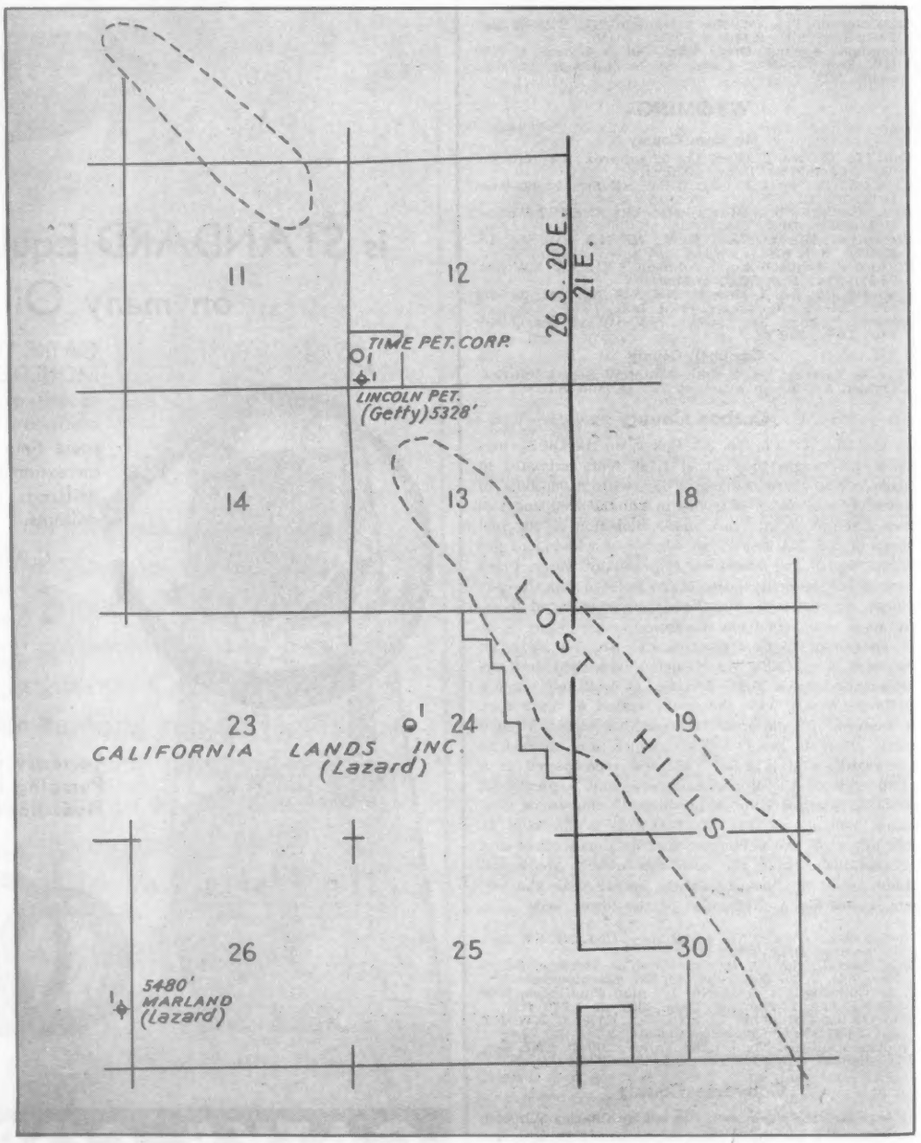
Superior Oil Co. extended the productive limits of the Rio Vista gas field which originally started in Solano County and was extended into Sacramento County, by completing No. 1 Reclamation Board as a commercial producer of dry gas. No. 1 Reclamation Board, located in Section 7-3-3, was brought in flowing 36,000,000 feet of gas per day from 3,883 feet through a 1-inch bean. The well was finished with a 7-inch water string landed at 3,819 feet and 89 feet of 4¾-inch liner including 60 feet of perforated and 3,385 feet of 1½-inch tubing. The well contains the smallest tubing used in this field.

Up in Humboldt County, Texas Co. recompleted No. 2 Eureka in Section 22-3-1 after plugging the hole back from 7,708 feet to 4,040 feet and then redrilling to 4,864 feet. No. 2 Eureka flowed 526,000 feet of gas per day. The hole was finished with 1,125 feet of 5¾-inch liner including 914 feet of perforated landed at 4,862 feet. The pipe record comprises 1,100 feet of 13-inch, 2,750 feet of 11¾-inch and 6,580 feet of 8⅝-inch most of the latter having been cut out before the redrilling job began.

In Glenn County, Ohio Oil Co. abandoned No. 2 Willard in Section 18-20-2 as this hole accomplished its purpose which was to mud off No. 1 Willard which blew out several months ago and wrecked the rig and equipment. The showing of No. 1 Willard tended to indicate the existence of a commercial gas field in the vicinity of Willows but a second well failed to find the accumulation indicated in the first hole. Additional exploration may be continued as original plans contemplated the drilling of a straight hole after No. 2 Willard, the directional hole, had been finished.

Montebello

The Hathaway Oil Co. is preparing to make a production test on No. 1 Dore in the extreme southwestern end of the Montebello field. This well is bottomed at 7,181 feet with the 8⅝-inch water string landed at 7,035 feet. If it results in commercial production it will prove up the existence of a productive zone below those now producing. In the meantime Herley-Kelly, Inc., is racing down to the lower zone and should reach it within a few days. During the past week three wells were completed, but none registered large production. Standard Oil Co. No. 1 Kaufman fee flowed 483 bbls. of 36.4-gravity oil and 23 bbls. of water per day on a compressor. It was finished at 6,465 feet with 125 feet of 6⅝-inch liner including 90 feet of perforated and 6,360 feet of 2⅛-inch tubing. Union Oil Co. completed No. 3 Paul Howard in the fifth zone, flowing 420 bbls. of 34.3-gravity oil daily from 5,465 feet through a 26/64-inch bean. Pressure is building up and production may increase. No. 1 Martin of Pongratz Oil Co. was good for 810 bbls. of 35.9-gravity oil per day upon completion in the sixth zone with bottom of the hole at 6,432 feet. St. Helens Petroleum Co. made a formation test on No. 2 Taylor and officials were agreeably surprised at the pressure the well showed. It encountered a faulted condition in the fifth zone which failed to carry any productive sand. A good sand was logged in the sixth zone. After finishing the formation test and while the crew was going back into the hole sparks, believed from the drawworks, ignited a small amount of gas in the cellar and this in turn ignited refuse oil. The fire burned for about two hours and while the derrick and equipment was damaged the well escaped. Well Developers, Inc., have



Time Petroleum Corp. will drill a wildcat in Section 12-26-20 between the Lost Hills field and the northwest extension where Tide Water Associated Oil Co., Standard Oil Co. and the Texas Co. have developed small shallow production of heavy oil

started grading a location on the Schnakenberg property just west of Standard Oil Co.'s most westerly producing well. In the eastern end of the west extension of the Montebello field, Union Oil Co. completed rig for No. 1 Calkins and will soon stake location for No. 1 Brown, still farther east and definitely east of the projected fault. The latter well should determine whether or not a major fault exists. One new location was staked in the west end of the Montebello field by Southern States Oil Co. on the Smith Community lease, a few hundred feet north and west of Beverly and Maple streets.

Rosecrans

Royalty Service Corp. focused the attention of operators on the southern end of the Rosecrans field this week when it made a formation test on No. 2 Gordon, bottomed at 7,783 feet. The well blew mud, oil and gas from 7 feet of formation with the tester open 15 minutes. When the tester was pulled the company recovered 15 stands of oil and 3 stands of mud and water. The bomb showed the bottomed hole pressure to be 3,000 pounds. A string of 8⅝-inch casing has been landed at 7,645 feet and plans are under way to make a production test within the next few days. Barnsdall Oil Co. No. 10 Rosecrans, which failed to find the O'Dea zone due to faulting, is the deepest well drilled in the Rosecrans field since its discovery at its present depth of 8,502 feet. The bit was still going ahead at last reports and no suspension depth has been made. The H. B. Oil Co. No. 1 Stephens, which blew in with only a few feet open below the shoe of the 7-inch water shutoff at 7,635 feet, is still holding up very close to its initial rate. The company is completing plans to drill a second well on the lease in the immediate future. Republic Petroleum Co. is rotating ahead in No. 1 Trust in oil sand and shale at 7,571 feet, having topped the O'Dea zone at 7,250 feet, and should be in a position to make a production test within another few days. Universal Consolidated Oil Co. plugged back No. 6 Trust from 7,976 feet to 7,577 feet due to faulting and has landed a 7-inch water string at 7,285 feet preparatory to an early production test.

Union Oil Co. has made a location for No. 28 Rosecrans in the Rosecrans field. Hydrocarbon Products, Inc., first well in this field will be making hole within a few days. Western Gulf Oil Co., which is drilling a wildcat east of the productive area of the Rosecrans field, has just passed the 5,900-foot level but still has some distance to go before reaching the Miocene, which is the objective. This wildcat is searching for an accumulation behind a known fault which practically parallels the axis of the Rosecrans structure.

Harbor City

In the Harbor City area Ring Oil Co. completed No. 4 Hawkins flowing 405 bbls. of 29.6-gravity oil per day through a 32/64-inch bean from 5,250 feet. Sierra Trading Co. No. 1 Spring bottomed at 5,300 feet but plugged back to 5,180 feet was put on the beam. The company ran in a solid string of 7-inch and subsequently perforated at 5,120-35 feet and at 5,160-80 feet. The well pumped 138 bbls. of 29.1-gravity oil the first 24 hours. Bass & Goodknight No. 52 Hawkins was finished at 5,231 feet, flowing 338 bbls. of 29.2-gravity oil daily through a 24/64-inch bean and appears to be holding up in good shape.

Initial production of Harbor City completions during the past 60 days has been far below expectations and the average drilling cost in this area is approximately $65,000 per well.

Wilmington

In the Wilmington field of Los Angeles Basin, Signal Oil & Gas Co. tideland development program should get under way within two weeks. General Petroleum Corp. completed No. 29 Harbor Community, flowing 364 bbls. of very clean 25.4-gravity oil and Union Pacific Railroad Co. finished the period by completing No. 10-E flowing 505 bbls. of very clean 21.6-gravity oil daily. The former was finished at 3,917 feet and No. 10-E of Union Pacific was bottomed at 3,774 feet.

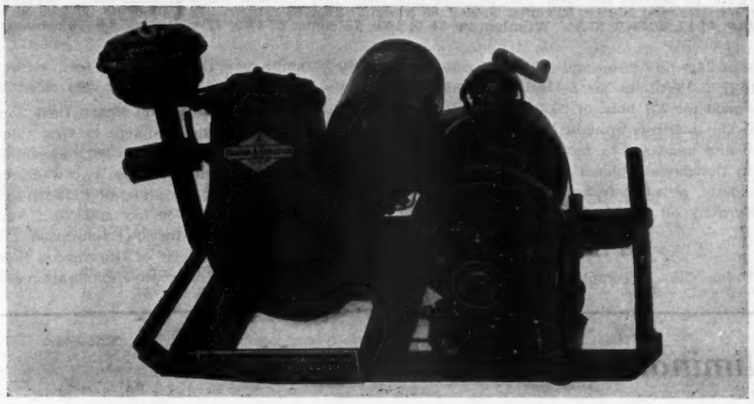
Torrance

In the Lomita section of the Torrance field Federated Oil Co. No. 1 Lomita showed an initial production of 186 bbls. of 27.4-gravity oil cutting 4 per cent from 5,981 feet. Standard Oil Co. which is running three strings of tools in the Lomita section of the Torrance field completed No. 1-15 Marble flowing 269

TOTAL TANKER SHIPMENTS FROM CALIFORNIA TO DOMESTIC AND FOREIGN PORTS

	November 5		October 28			
Intercoastal-domestic—	Total this week	Daily average	Total last week	Daily average	This year to date	Same time last year
Crude oil	.....	.....	.....	.....	852,826	129,788
Diesel and gas oil	.....	.....	.....	.....	196,644	399,056
Gasoline	.....	.....	.....	.....	2,657,250	3,692,700
Kerosene	.....	.....	76,621	10,946	349,750	401,657
Asphalt	.....	.....	.....	.....	490,039	413,885
Lubricants	.....	.....	.....	.....	19,945	25,522
Foreign exports—						
Crude oil	794,936	113,562	486,276	69,468	23,537,545	16,141,334
Fuel oil	262,610	37,516	192,296	27,471	10,143,511	14,096,747
Diesel and gas oil	303,945	43,421	316,248	45,178	7,984,491	9,227,291
Gasoline	418,668	59,810	140,463	20,063	11,743,407	11,219,635
Kerosene	49,362	7,052	33,338	4,763	1,641,627	2,791,081
Asphalt	.....	.....	.....	.....	56,258	.....
Lubricants	40,112	5,730	2,172	310	701,239	487,478
Other unfinished oil	.....	.....	.....	.....	.....	974,785
Coastwise-domestic—						
Crude oil	117,608	16,801	114,316	16,331	10,017,543	4,807,622
Fuel oil	514,471	73,496	600,676	85,811	15,783,713	18,892,756
Diesel and gas oil	58,307	8,330	67,750	9,679	2,674,760	3,201,626
Gasoline	434,574	62,082	369,151	52,736	19,377,489	18,321,674
Kerosene	25,932	3,705	37,918	5,417	753,418	706,254

ANNOUNCING!



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STANDARD OIL CO. OF CALIFORNIA AND UNION OIL CO.
Crude oil prices at the well effective June 22, 1936

Gravity—	Signal Hill (Long Beach)	Seal Beach	Alamitos Heights	Huntington Beach	Inglewood	Playa del Rey	Olinda-Brea Canyon	Athens-Rosecrans	Dominguez	Elwood Terrace	Torrance	Richfield	Whittier E. Coyote (La Habra)	Montebello	W. Coyote Hills	Santa Fe Springs	Mountain View	Elk Hills Buena Vista Hills Midway-Sunset Lakeview Area	Lost Hills	Coalinga	Wheeler Ridge	Kettleman Hills	Santa Paula*	Orcutt*
14-14.9	$.80	$.79	$.74	$.78	$.79	$.80	$.76	...	...	...	$.80	$.76	$.76	$.77	$.78	...	...	$.70	$.70	$.70	...	...	$.70	
15-15.9	.80	.79	.74	.78	.79	.80	.76	..	..	...	.80	.76	.76	.77	.78	...	...	.70	.70	.70	...	...	.70	
16-16.9	.80	.79	.74	.78	.79	.80	.76	..	..	...	.80	.76	.76	.77	.78	...	...	.70	.70	.70	...	...	.70	$.70
17-17.9	.80	.79	.74	.78	.81	.80	.76	...	...	...	.80	.76	.76	.77	.78	...	...	.70	.70	.70	...	...	.71	.70
18-18.9	.80	.79	.74	.78	.84	.80	.78	...	...	...	.82	.76	.76	.77	.78	...	...	.70	.70	.70	...	...	.73	.72
19-19.9	.82	.79	.74	.82	.87	.84	.81	...	...	...	.85	.76	.78	.77	.78	...	$.70	.74	.74	.71	$.70	...	.75	.74
20-20.9	.85	.79	.74	.85	.90	.88	.84	...	...	...	.88	.78	.82	.77	.80	...	.70	.78	.78	.72	.70	...	.77	.77
21-21.9	.88	.79	.74	.89	.93	.93	.88	...	...	...	.91	.80	.85	.77	.84	$.78	.73	.82	.82	.74	.70	...	.79	.80
22-22.9	.92	.82	.74	.92	.96	.98	.92	...	...	...	.93	.84	.89	.79	.88	.78	.77	.87	.86	.78	.72	...	.82	.83
23-23.9	.95	.86	.77	.96	.99	1.02	.96	$.84	$.79	...	.96	.88	.93	.82	.92	.78	.80	.92	.90	.82	.76	...	.85	.86
24-24.9	.99	.91	.80	1.00	1.02	1.06	.99	.88	.81	..	.99	.91	.96	.85	.96	.82	.84	.97	.94	.86	.79	...	.87	.88
25-25.9	1.03	.95	.82	1.03	1.05	1.11	1.03	.93	.83	...	1.02	.95		.89	.99	.86	.88	1.01	.98	.90	.83	...	.90	.91
26-26.9	1.06	1.00	.85	1.07	1.09	1.16	1.06	.98	.86	...	1.05	.98	...	.92	1.03	.90	.91	1.06	1.02	...	...	...	.92	.93
27-27.9	1.10	1.05	.88	1.11	1.12	...	1.10	1.03	.88	...	...	1.02	..	.96	1.06	.95	.95	1.10	1.06	...	...	...	.95	..
28-28.9	1.14	1.10	.90	1.14	1.15	...	1.14	1.07	.90	...	...	1.06	...	.99	1.10	.99	.99	1.15	1.10	...	...	...	.97	..
29-29.9	1.17	1.15	.93	1.18	1.18	F.O.B.	1.17	1.12	.93	...	...	1.09	...	1.03	1.14	1.03	1.02	1.20	1.14	...	...	...	.99	..
30-30.9	1.21	1.19	.95	1.22	1.21	our	1.21	1.17	.95	F.O.B.	...	...	...	1.07	1.17	1.08	1.06	1.25	1.18	...	...	...	1.01	..
31-31.9	...	...	...	...	1.24	Pipe	1.24	1.22	.97	Ship	...	...	...	1.11	1.21	1.12	1.09	1.29	...	...	...	...	...	..
32-32.9	...	...	...	...	1.27	Line	1.27	1.27	1.00		...	...	...	1.14	1.25	1.16	1.13	1.34	...	...	...	...	...	..
33-33.9	...	...	...	...	...	...	...	1.32	..	1.28	...	...	...	1.18	1.28	1.20	1.17	1.38	..	..	..	$1.19	...	..
34-34.9	...	...	...	...	...	...	...	1.37	...	1.32	...	...	...	1.22	1.32	1.25	1.20	..	..	..	..	1.23	...	..
35-35.9	...	...	...	...	...	...	...	1.42	...	1.35	...	...	...	1.25	...	1.29	..	..	..	..	..	1.27	...	..
36-36.9	...	...	...	...	...	...	...	1.46	...	1.39	...	...	...	1.29	...	1.33	...	..	..	..	..	1.31	...	..
37-37.9	...	...	...	...	...	...	...	1.51	...	1.43	...	...	...	1.32	...	1.37	...	..	..	..	..	1.35	...	..
38-38.9	...	...	...	...	...	...	...	1.56	...		...	...	...	1.36	...	1.42	...	..	..	..	..	1.39	...	..
39-39.9	...	...	...	...	...	...	...	1.61	...		...	...	...	1.40	...	...	...	..	..	..	..	1.43	...	..
40-40.9	...	...	...	...	...	...	...	1.66	...		...	...	...	1.43	...	...	...	..	..	..	..	..	...	..

Newhall, McKittrick, Kern River, Kern Front and Round Mountain, 70 cents for all grades. *Posted by Union Oil Co. Same company's Brea Canyon schedule stops at $1.14 for 28 degrees and over, and Belridge and Lost Hills schedule stops at $1.32 for 37 degrees and over. By Standard Oil Co., effective October 15: El Segundo, 14 to 18.9 degrees, 80 cents; 19-19.9, 82 cents; 20-20.9, 85 cents; 21-21.9, 88 cents; 22-22.9, 92 cents; 23-23.9, 95 cents; 24-24.9, 99 cents; 25-25.9, $1.03; 26-26.9, $1.06; 27-27.9, $1.10; 28-28.9, $1.14. 29-29.9, $1.17; 30-30.9, $1.21. Wilmington, 14 to 16.9, 75 cents; 17-17.9, 77 cents; 18-18.9 79 cents from 19 degrees upward, prices same as Signal Hill.

bbls. of 25.3-gravity oil and 8 bbls. of water from 4,980 feet. J. E. Pettijohn No. 1 Koala finished at 4,967 feet was good for 351 bbls. of 26.3-gravity oil upon completion. The well was brought in flowing through a 1-inch bean and appeared to have settled at its initial flow. A. A. Douglas completed a small pumping well, No. 1 Beaudette, at 4,982 feet. It started off at 65 bbls. of 26.3-gravity oil cutting 3 per cent.

Los Angeles Basin

Union Oil Co. completed No. 63 Callender in the Dominguez field at 7,485 feet, with an initial daily production of 235 bbls. of very clean 29.8-gravity oil.

In the Huntington Beach field Southwest Exploration Co. should complete its first tideland well within the next few days and will follow this with a second potential producer. These two wells, drilled on a lease secured from the State of California, are No. 1 State in the pay at 3,750 feet and No. 2 State in the pay at 3,640 feet. Southwest Exploration Co. has made its peace with the city of Huntington Beach and will proceed with its aggressive exploration program which involves a total of 88 wells to be bottomed beneath the tidelands. In the Lovelady section of the Long Beach field, De Soto Oil Co. is coring ahead at 9,830 feet in a formation consisting of sandy shale with streaks of oil sand but has not yet found enough oil sand to justify the expectation of developing commercial production. This well, which stuck drill pipe at 9,674 feet and then circulated it loose with oil, is the deepest hole drilled in the Long Beach field. Texas Co. has reached a depth of 5,298 feet in No. 1 Anderson-Spring a wildcat in the Ocean Park district located in the coastal plane but is not deep enough to find the pay.

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CLEVELANDS

Greeley—Wasco

Superior Oil Co. staked location for a well to be drilled in the Greeley field of Kern County, where the company has already drilled two unsuccessful tests. The new well will be No. 12 Kern County Land in section 3-30-26, a few hundred feet southeast of its two dusters. Superior's first wildcat in this area was No. 9 Kern County Land, which flowed 800 bbls. per day for two days from 11 feet of oil sand and then went dead. The company was unable to revive the well. A second well, No. 10 Kern County Land, was drilled southeast of the initial well but it failed to find anything and was abandoned. Superior Oil Co. then went back into No. 9 Kern County Land, the initial well, and whipstocked it to the northeast, but failed to find the pay. Standard Oil Co. made a formation test on No. 1 Mushrush in the Wasco field of Kern County this week and the well flowed at the rate of 2,750 bbls. per day with the tester open at 13,075-139 feet. The oil was relatively clean and tested 36.1 degrees. Continental Oil Co. is having trouble with water in No. 3-A Kern County Land. The company staked location for No. 4-A Kern County Land one location southeast of No. 2 Kern County Land, its discovery well. The wildcat southeast of production in the Wasco field which was a joint undertaking will be abandoned as a duster with bottom at 13,064 feet as it not only failed to show oil production but produced salt water.

Kern County

Shell Oil Co. completed a small well in the Ten Section field when No. 47-20-B Kern County Land in Section 20-30-26 was swabbed in through two 1-inch beans following completion at 8,211 feet. This new well, which is located rather far out on the north flank of the structure, showed a maximum potential of 262 bbls. of 34.4-gravity oil cutting 23 per cent and 177,000 feet of gas per day. The well was put on a gas lift and production appears to be cleaning up. In the Round Mountain field, Shell completed No. 1-15 Jewett in Section 29-28-29 pumping 82 bbls. of 14.7-gravity oil cutting 9 per cent daily from 1,770 feet after the hole had been finished with 450 feet of 5½-inch liner including 428 feet of perforated. In the Mountain View field, Hogan Petroleum Co. completed No. 10 Wharton

(Continued on Page 236)

North Louisiana, Arkansas

By GEORGE WEBER

Important Developments in Cotton Valley and Magnolia

SHREVEPORT, La., Nov. 14.—The Cotton Valley field of Webster Parish, the Shreveport area of Caddo Parish, and the Magnolia-Village area of Columbia County, Arkansas, showed important developments during the past week. Interest was also directed to the Miller County, Arkansas, section of Rodessa, where a northward extension was being brought in, the recently revived Rainbow field of Union County, where a new sand is making good producers, and the Schuler field in the same county, which apparently is further defined on the northeast.

Cotton Valley tests on the south and southwest edge of the structure continued to attract considerable interest. Mid States Oil Corp. No. 1 Welori Lumber Co. Unit, an east offset to the company's discovery well in the "D" sand on the south edge of production, topped the "D" section at 8,521 feet and cored the sand to 8,553 feet. The Bodcaw sand was topped at 8,619 feet. Operators cored to a total depth of 8,673 feet. In the Bodcaw section, gas and distillate sand was cored at 8,619-40 feet, and oil saturation was found at 8,640-42 feet. The remaining section to 8,665 feet was a tight limy sand showing no oil saturation.

This indicates for the first time, the apparent gas-oil contact in the Bodcaw sand, which produces gas and distillate over most of its extent on the Cotton Valley structure, and is producing oil in two outpost flank wells on the northwest and southeast. The contact is set at 8,395 feet subsea.

Although a good section of Bodcaw was cored in the Mid States well, the "D" sand showed excellent saturation throughout its thickness, and the well will be plugged back, perforated and completed in that body.

The apparent limit of the oil producing band in the "D" sand of the field is indicated by results in the Hunt Oil Co. No. 1 Sandifer, a west offset well to the "D" sand discovery well, and one-half mile west of the Mid States well, which cored the Bodcaw and found the gas-oil contact. The Hunt test cored the "D" sand at 8,534 feet and the sand showed oil in cores to 8,550 feet. The test was drilled to 8,720 feet, showing gas and distillate in the Bodcaw sand, and casing was set and perforated at 8,540-65 feet. A disappointing production test showed salt water in the "D" sand. Operators are planning to retest, having squeezed-off perforations made in the sand.

In a southwest outpost well, Oliphant Oil Co. No. 1-B Stewart, C NW SE Section 5-20-10, was last reported coring at 9,120 feet. The well after salt water in both the "D" and Bodcaw sands was found, was deepened, coring Davis sand at 9,003-06 feet, which had a gas odor, and encountering shale and sandy shale at 9,055-89 feet and sand at 9,089 feet.

On the northeast edge of the field, Hunt Oil Co. No. 22 Hope Estate, C SE SE Section 24-21-10, was cored in the Holloway sand at 5,722-38 feet and blew in with gas, making 128 bbls. of oil in 14 hours. The well is being tested. Total depth is 5,900 feet.

Shreveport Area

Completion of the R. L. Bauman No. 1 Slattery Estate as a gas well further complicated developments in the Shreveport field this past week. Second well of its kind, following completion of the R. E. Allison No. 1 State recently, the new well, located southeast of the discovery well, was showing decreased amounts of gas late in the week on numerous gauges.

Originally the well, when perforated at 5,548-54 feet, tested 10 bbls. per hour of high gravity oil, and an estimated 8,000,000 feet of gas on a 23/32-inch choke, tubing pressure 700 pounds, and casing pressure 1,450 pounds. Total depth is 5,604 feet. Later in the week three hourly production gauges were made. During the first hour it gauged 4 bbls. of oil, 2,304,000 feet of gas with tubing pressure of 2,050 pounds and casing pressure of 5,110 pounds on a one-fourth inch choke. The second hourly gauge showed 5½ bbls. of oil, 2,370,000 feet of gas, 1,900 pounds tubing pressure and 2,010 pounds casing pressure on a 5/16-inch choke. The third test showed 8 bbls. per hour, 4,568,000 feet per day of gas, 700 pounds on the tubing, 1,475 pounds on the casing while on a three-fourths inch choke.

The decrease in gas-oil ratio was shown by a gauge made two days later, showing 12 bbls. of 54-gravity oil per hour, and 2,250,000 feet per day of gas, with tubing and casing pressures equalized at 900 pounds, and 148 pounds working pressure on the separator. The last gauge was made through a three-fourths inch choke.

To the southwest, the C. D. Loe No. 1 Meyer has topped the Pettit horizon at 5,592 feet and the crew was running an electrical survey with hole bottomed at 5,628 feet. In the same area, Rodessa Oil & Refining Co. No. 1 Chandler is drilling in lime and shale approaching the pay section.

The five mile outpost, Hollywood Oil Corp. No. 1 C. & B. Realty Co., southwest of Shreveport near the Mansfield highway, was abandoned after showing salt water in several sand sections. Perforations made successively at 4,954-65 feet, 4,920-35 feet, 4,870-80 feet and 4,820-28 feet resulted in salt water and the well was plugged at a total depth of 6,009 feet. The well had shown no oil in the Pettit or the Jeter horizons.

Arkansas

The Magnolia field of Columbia County continues to revive, as G. H. Vaughn No. 2 Garrett was completed in the past week. The well, which showed the steepest dip in the lime yet discovered, and cored over 100 feet of saturated section, came in making 425 bbls. of oil through a one-fourth inch choke with tubing pressure of 1,400 pounds and casing pressure of 1,500 pounds. Total depth is 7,522 feet.

Meanwhile, Atlantic Refining Co. No. 1 Garrett, northeast of the Vaughn No. 2 Garrett, and in an east offset position to the Vaughn No. 1 Garrett, a producer, was cored in the section and casing was set. The top of the lime was cored at 7,519 feet, oolitic lime at 7,622 feet and a drill stem test was made at 7,604-22 feet, the crew using a one-fourth inch bottom choke. The recovery was 2,800 feet of oil and 200 feet of brackish water, in 11 minutes, with working pressure of 35 pounds and a bottom hole pressure of 3,500 pounds. Porous lime was topped at 7,548 feet. A string of 7-inch casing is being set at total depth, 7,627 feet. Encouraged by the comeback of the field, which had been dormant after three dry holes limited production on the east and west several months ago, three new wells are being started.

Wildcat Show

About seven miles southeast of the edge of the Magnolia pool in Columbia County, Tide Water Seaboard No. 1 J. T. Beene, C SE NW Section 15-18-19, a wildcat, had a slight show of oil. On a four-foot recovery of a section cored at 7,000-08 feet, a stain of oil was noted. At 7,020-32 feet, the recovery showed 1 foot of water sand and 6 feet of gray sand and shale, with no show. Operators are drilling ahead below 7,045 feet.

Schuler Limit

On the northeast edge of the Schuler, a second apparent failure indicates the limits of production on the north. The Phillips Petroleum Co., after topping Jones sand at 7,630 in No. 1 Edwards, setting casing and perforating, found that the well would not flow. Casing was reperforated at 7,626-35 feet and the crew swabbed the hole dry, and shut down, awaiting orders.

The Rainbow field of Union County is receiving considerable attention as the new horizon develops oil and gas wells. This past week the Ohio Oil Co. brought in No. 5 Furlough for 420 bbls. of oil and 400,000 feet of gas daily on a three-eighths inch choke, with tubing pressure of 300 pounds and casing pressure of 515 pounds. It was perforated at 2,981-94 feet with total depth at 3,010 feet.

Miller County

A one-half mile northward extension to the Miller County section of Rodessa was evident from tests made on the F. W. Martin Drilling Co. No. 1 Watts, located in Section 2-20-26. The well flowed 300 bbls. of oil and 75 bbls. of salt water in 17 hours on a one-half inch choke with tubing pressure of 125 pounds and 1,250 pounds on the casing. A string of 5-inch casing is set at 6,219 feet and operators are planning to plug back to 6,210 feet to cut off the salt water sand. Total depth is 6,252 feet.

Estimated daily gross production of all companies week ending November 10, 1938:

Estimated Production

NORTH LOUISIANA

	Bbls.
Bellevue	660
Caddo light	4,125
Caddo heavy	2,530
Converse	560
Cotton Valley heavy	90
Cotton Valley light	11,065*
Cross Lake	600
De Soto and Red River	1,295
Elm Grove	350
Haynesville	2,835
Holly	80
Homer	2,620
Lisbon	4,990
Pleasant Hill	105
Rodessa	30,915
Sarepta-Carterville	320†
Sligo	1,640
Sugar Creek	290
Urania	2,645
Zwolle	3,875
Total	71,590

SOUTH ARKANSAS

Buckner	1,565
Champagnolle	1,400
El Dorado	1,825
Lisbon	265
Miller County	360
Nevada	620
Rodessa	4,880
Schuler	16,985
Smackover light	2,010
Smackover heavy	15,665
Stephens	550
Troy	1,125
Urbana	1,180
Village	940
Total	49,370

Texas side of Rodessa field 29,405 bbls. daily.
*4,825 bbls. is distillate.
†100 bbls. is distillate.

California Arabian to Test Entirely New Structure

California Arabian Standard Oil Co., wholly-owned subsidiary of Standard Oil Co. of California, operating a large concession in eastern Saudi Arabia, is well advanced on a program for testing an entirely new structural feature about 100 miles north and west of the Dammam field which has proven highly prolific from a deeper horizon around 4,700 feet. Camp for the drilling crew is practically completed. The area to be tested is around Abu Hadriya.

Meanwhile, deepening of the remaining seven tests on the Dammam structure to the production level at 4,700 feet continues and this program will be followed up until completed.

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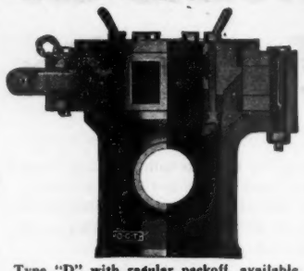

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Among the Drilling

HOUSH & THOMPSON moved a rotary to the Pearland area, Brazoria County, Texas, where No. 1 N. A. Means will be drilled for the Carroll Oil Co. and others. The well is east of the town of Pearland in the T. J. Green Survey. Northwest of the Conroe field, Montgomery County, Housh & Thompson No. 1 Clary is bottomed in the Conroe sand at 4,739 feet, and casing is being cemented for completion. This well showed evidence of commercial production on a drill-stem test, and is expected to add another field to the Conroe trend.

N. W. HUNTER received contract from the Wittjen Oil Co. for an interesting outpost test 1 mile southwest of the Hitchcock field, Galveston County, Texas, and the well will be spudded during the week. The test is on the Coon lease in the Arthur Burke Survey.

GEORGE ECHOLS has started drilling operations on two important wells in the newly opened League City field, Galveston County, Texas. Two miles north of the discovery well, H. C. Cockburn No. 1 Haardt is drilling below 4,600 feet, while George Echols No. 1 Stewart-Ross is drilling below 3,000 feet.

ALLEN & MORRIS are completing another producer in the La Rosa field, Refugio County, Texas, for I. J. Allen, as No. 1 Yarrow is cleaning into the pits from perforated casing at 5,902-5½ feet. The same operators No. 2 Spaulding is drilling below 6,209 feet. In the Luby field, three rotaries are operating for the Seaboard Oil Co., while in the Greta field, one rotary is operating for the Missouri-Pacific Railroad.

CROSBY DRILLING CO. is starting drilling operation on the company's No. 1 John Broughton, midway between the discovery well of the Francitas field and the town of Francitas, Tex. The well is on a farmout lease from the Texas Co. and is in the center of Lots 44 and 45, Block 6, Patrick Green Survey.

RICHARDS & HOLLOWAY, of Tyler, Tex., have opened a new producing area in Leon County, East Central Texas. The well is the Richards & Holloway and J. K. Hughes and others No. 1 Sam Bain, in the K. M. Webb Survey, about 4 miles south of Keechi. It flowed 13 bbls. hourly with some basic sediment and water under pressures registered at 1,700 pounds on the casing and 750 pounds on the tubing. Total depth is 5,895 feet and production is through perforations in the casing from 5,510-20 feet.

AL BUCHANAN completed Magnolia Petroleum Co. No. 10 Seeligson as a distillate well to extend the East Premont field, Jim Wells County, Texas. In the Seadrift area, Calhoun County, Hiawatha Oil & Gas Co. No. 2 J. J. Roemer is drilling in shale below 9,470 feet.

BUTLER & HORNE DRILLING CO., of Dallas, Tex., opened a new Cook sand pool in northwestern Shackelford County, Texas, in the NW Section 153, E.T. Survey, when 5 feet of pay sand was drilled from 1,398 feet to 1,403 feet. The new producer is the first well for Butler & Horne on their properties in the area although they have been contracting in West Central Texas for several years. The well is in the J. H. Nail ranch. The discovery well for the ranch was drilled and produced in the Bluff Creek sand at 1,350 feet and did not reach the Cook horizon.

HELMERICH & PAYNE, of Tulsa, have been awarded contract to deepen a test in the Pardue area of southern Haskell County, Texas, approximately 5 miles northeast of Stamford. Test is Forest Development Corp. No. 3 Pardue, in Section 4, M. Collum Survey, and is being deepened from the Adams Branch lime, producing horizon of the pool, where it tested salt water. Operators plan to test the Strawn, Bend, and Ellenburger, which will carry it down about 5,000 feet.

GRACE & WOODS, of Wichita Falls, Tex., have spudded and set 100 feet of surface casing in a scheduled 4,600-foot wildcat test being drilled for Southern Oil & Gas Co. in the southwestern part of Jack County, North Central Texas. Location is in the Barton Chapel area where in 1922 Roxana (Shell) drilled No. 1 J. R. Williams, in the B.S.&F. Survey, which is still flowing 14 bbls. of oil daily from a depth of 4,488 feet. Tom C. Patten (Southern Oil & Gas) assembled the block and in so doing required the signatures of 167 different persons in 23 states and two foreign countries, showing the extent to which acreage, even for miles around the old Roxana well, had been circulated.

UNGREN & FRAZIER, of Abilene, Tex., have indicated a new pool or a 2-mile extension to the Avoca pool

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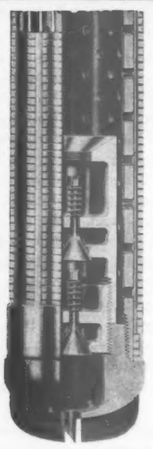
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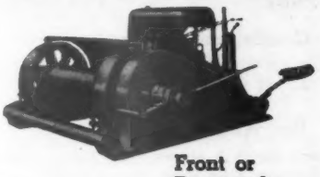

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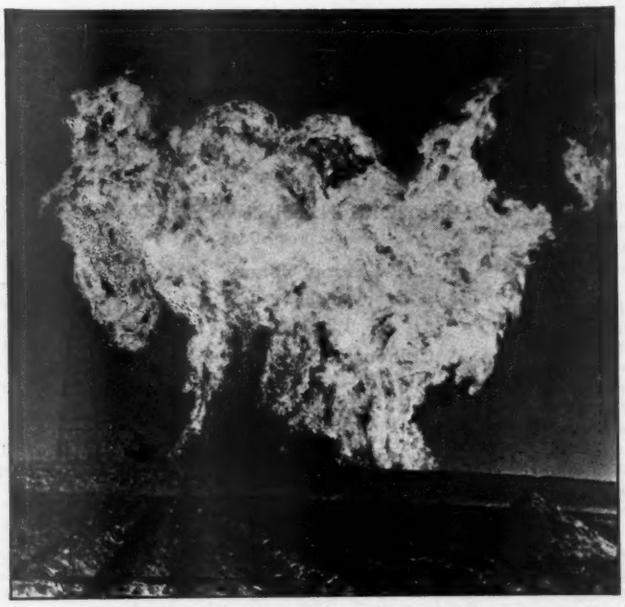
SHERMAN SHELTON, drilling contractor throughout South Texas, has received contracts from Trans-Pecos Oil Co. for deep development in the western part of Pecos County. The company will deepen two wells to the Delaware sand horizon, No. 1 Popham Land & Cattle Co. and No. 1 Gallaher. No. 1 Popham, Section 235, Block 11, G.H.&S.A. Survey, now bottomed at 2,300 feet, is expected to encounter the Delaware horizon at about 4,800 feet. At that level the rotary will be shifted to No. 1 Gallaher, Section 9, Block 51, T.&P. Survey, which is now bottomed at 2,240 feet. Both tests will be deepened into the expected pay sand with standard tools after the Delaware lime is topped.

H. H. HOWELL, contractor of Corpus Christi, Tex., has received contract for two wildcat tests to be drilled by J. O. Hart & Sons in Kerr County, Texas. One of the tests has been spudded and will seek production from around 6,000 feet. It is in Jones County, West Central Texas. The test is their No. 1 Griffin, in the S half Section 199, B.B.B.&C. Survey. The lime horizon was topped at 3,247 feet, and after taking only 3 feet of penetration the well began heading oil. The new well will probably open another producing area as there is a dry hole between it and the Avoca pool.

VIRGINIA DRILLING CO. is starting to drill a wildcat as the result of a deal involving R. S. Webb, Dwight J. Wilson, and Sam Murphy. The test will be at No. 1 Clawson in SW NW Section 17-20-11w, 2½ miles south of Ellinwood and 1½ miles south of the Ellinwood pool in Barton County, Kansas. Champlin Refining Co., Pure Oil Co. and Shell Petroleum Corp. are supporting the test.

RUTHERFORD DRILLING CO. extended the La Rosa field, Refugio County, Texas, about a half mile northeast with the completion of Rutherford Oil Corp. No. 1 Schrimer. It was completed in a new sand below 6,200 feet, and is reported to be flowing an estimated 15 bbls. of oil and wash water per hour while cleaning out. The company has approximately 350 acres in the area and new operations are expected to be started at an early date.

CROW DRILLING CO., Shreveport, La., is drilling a semiwildcat near production near the North Cramm pool, Rice County, Kansas, for Shell Petroleum Corp.



Night scene at burning well, No. 2 Simmons, Saxet field, Nueces County, Southwest Texas

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Southwest Texas District

By
F. L. SINGLETON

Plans for Development of McAllen Field by Phillips

CORPUS CHRISTI, Tex., Nov. 14.—The testing of several widely scattered wildcats and the opening of new producing horizons in proven fields held the attention of operators in the Southwest Texas district.

Pure Oil Co. and others No. 1 State, in Laguna Madre Bay, offshore from Kleberg County, has cemented 7-inch casing and is expected to be tested this week. Detailed information as to the depth at which the well will be tested has been withheld by the company. The hole is bottomed below 9,636 feet, and the casing is reported to have been cemented on bottom. The well is about a half mile west of North Bird Island, on State tract No. 168.

In Nueces County, Stanolind Oil & Gas Co. No. 1 Wilson, 8 miles northwest of Robstown and in the Jose Vincente Lopez de Harrera Survey, showed evidence of opening a new gas field when an 8½-minute drill-stem test at 4,211-24 feet, indicated 400 pounds of dry gas pressure. The showing was found in the Heterostegina section and the well is being drilled to the Frio formation.

The crew at Steinberger Petroleum Co. No. 1 Albrecht, north of the town of Goliad, in Goliad County, was preparing to make another production test after running screen. The hole is bottomed at 5,313 feet and casing was perforated at 5,239-43 feet, but the well failed to flow and it is believed the screen sanded up. While swabbing, the well showed a small amount of oil and several hundred pounds of gas pressure. Location is in the Thomas Hancock Survey.

South Alice Field

In the South Alice field, Jim Wells County, Pratt & Browning were attempting to open a new horizon with the testing of No. 2 Stillwell which is bottomed in shale at 5,571 feet with 5-inch liner set to test an oil sand at 5,560-66 feet. The second producer for the newly-opened 5,400-foot horizons was indicated by Coates and others No. 4 Stillwell. Sand showing oil was logged at 5,456-68 feet, and on a drill-stem test at 5,456-68 feet, 60 feet of oil was recovered and the working pressure built up to 150 pounds.

In the southern part of Jim Wells County and located near the town of LaGloria, Shell Petroleum Corp. No. 1 Von Blucher is coring shale at 7,392 feet. This test showed evidence of opening a new distillate field last week when it tested 500 pounds of working pressure and 20 feet of gas cut drilling mud on a drill-stem test through perforated casing at 7,327-30 feet. In the west central part of the county, Magnolia Petroleum Co. No. 1 Romano V. de Garcia, the second test to be drilled in the Banderia gas field, was completed for an initial production of 5,865,000 feet of gas and 44 bbls. of distillate per day flowing through a three-eighths inch choke. The well is located 1,126 feet east of the discovery well and production was obtained by perforating the casing in the gas sand at 6,421-26 feet.

Magnolia Petroleum Co. No. 10 Seeligson, 1,320 feet west of the East Premont field, Jim Wells County, was completed through perforated casing at 5,807-12 feet, and the well flowed 2¼ bbls. of distillate per day through a quarter-inch choke. Tubing and casing pressure was equalized at 2,450 pounds. One and a half miles south of production, in the S. K. & K. Survey, Transwestern Oil Co. No. 1 Dunlap is waiting on cement to set after making a cement squeeze job at 5,365-70 feet, preparatory to completing in the discovery horizon below 6,000 feet.

L. L. Smith and others No. 1 H. F. Barfoot has indicated another sizeable extension to the McCampbell field in Aransas and San Patricio counties as casing is being cemented for a production test after the well had logged approximately 16 feet of oil sand at 7,118-36 feet. Showings were also logged in the 6,500- and 6,800-foot sands. The well is located 4,150 feet southwest of Frank Grote No. 1 Tedford, recently completed to extend production within a quarter of a mile of the Aransas Pass city limits.

Planning McAllen Development

In the McAllen area, Hidalgo County, R. E. Harding and others No. 1 F. M. Card, lot 8, Block 8, Hidalgo Canal Company Subdivision just east of the McAllen city limits is flowing 5,000,000 feet of gas and a small amount of distillate per day after reperforating the casing at 7,440-65 feet. The well is flowing through a three-eighths inch choke under a working pressure of 1,800 pounds.

Phillips Petroleum Co. acquired an option on the well and approximately 14,500 acres from R. E. Harding and his associates and is reported to have spent more than $250,000 for additional acreage in the area. Officials of the company say future development in the area depends on what kind of city ordinance will be passed by McAllen City Commission regulating drilling of wells within the corporate limits. The company has asked the city commission that wells be limited to 40-acre tracts, in order to prevent waste and allow an efficient development program. No. 1 Card is believed to be on the apex of the structure, which is said to cover approximately 6,000 acres, of which approximately 1,500 acres are in the city limits.

In the Balcones fault line district, a small chalk field was apparently opened in Guadalupe County by A. D. King No. 1-A H. Rosenbrock, Vincente Duran Survey. The hole is bottomed in the Buda lime at 1,882 feet, and it is reported that the well is flowing and swabbing approximately 25 bbls. of 18 gravity oil per day from the Chalk formation at 630-980 feet. In the G. Torres Survey, R. A. Williams and others No. 1 C Weber is swabbing, showing a small amount of oily mud from the Edwards lime bottomed at 1,483 feet. The lime section was topped at 1,468 feet.

In Bastrop County, Continental Oil Co. has taken over Paul Teas and others No. 1 J. T. Grizzard and the hole has been plugged back to 7,150 feet, where preparations are being made to test. The hole was drilled to the Edwards lime at a total depth of 7,175 feet where the well swabbed sulfur water.

An important north extension to the newly-opened Kelsey field, Jim Hogg County, was indicated by the showing of Humble Oil & Refining Co. No. 3-Kelsey Bass, 3,732 feet north of the discovery well in the San Raphel grant. Sand showing oil and gas was logged at intervals at 4,713-35 feet, and on a 20-minute drill stem test at 4,700-36 feet, 500 feet of oil and 370 feet of oily mud was recovered. The discovery horizon was topped slightly higher than the discovery well.

COMPLETIONS IN SOUTHWEST TEXAS

(24-hour production)

Bastrop County

Coffey field: Philtop Oil & Gas Co. No. 3 Cassin, 1,113½ feet, 75 bbls., pumping.

Calhoun-Victoria Counties

Heyser field: George Echols No. 14 Bennett, perforated casing 5,485-95 feet, 181 bbls., one-eighth inch choke. Sinclair Prairie Oil Co. No. 17 W. H. Bennett, perforated casing 5,572-82 feet, 285 bbls., one-eighth inch choke.

Duval County

Benavides field: Benedum & Trees No. 19 Puig, perforated casing 4,750-60 feet, 82 bbls., five-thirty-seconds inch choke. Casa Blanca field: Magnolia Petroleum Co. No. 2 Duval County Ranch Co., 1,200 feet, dry gas well. Driscoll field: Continental Oil Co. No. 28-A Driscoll, sand 3,348-61 feet, 246 bbls., one-fourth inch choke. Fitzsimmons field: Collins & Porter No. 3 Fitzsimmons, perforated casing 4,354-81 feet, 230 bbls., one-fourth inch choke. McAlester Fuel Co. No. 2 Mew, perforated casing 4,370-78 feet, 108 bbls., 11/64-inch choke. Hoffman field: Continental Oil Co. No. 3 Collings, sand 2,799-2,807 feet, 275 bbls., three-eighths inch choke. Cox, Hamon, Gorman and others No. 48 Cuellar, 2,602 feet, 90 bbls., jetting. Magnolia Petroleum Co. No. 18 Weil, sand 2,530-48 feet, 144 bbls., jetting.

Guadalupe County

Darst Creek field: McCabe & Dabb No. 1-A Wilson, 2,575 feet, 117 bbs., 21 hours pumping.

Jim Wells County

Armagosa field: Smith & Storey No. 3 McGill, 3,018 feet, abandoned. South Alice field: Blanco Oil Co. and others No. 4 Rattan, perforated casing 5,290-5,300 feet, 165 bbls., three-sixteenths inch choke. H. H. Howell and others No. 2 Stillwell, perforated casing 5,271-83 feet, 152 bbls., one-eighth inch choke. H. H. Howell No. 2-A Stillwell, perforated casing 5,270-80 feet, 40 bbls., one-eighth inch choke.

McMullen County

Ezzell field: E. M. Jones No. 37 Ezzell, perforated casing 1,514-26 feet, 40 bbls., pumping. E. M. Jones No. 41 Ezzell, 1,604 feet, abandoned. Munson field: Duncan & Graham No. 1-A Nueces Land & Livestock Co., sand 1,203-12 feet, 10 bbls., pumping. Duncan & Graham No. 1-B Nueces Land & Livestock Co., sand 1,201-20 feet, 71 bbls., pumping. San Jose field: V. G. Schimmel No. 3-A Kountz, 1,186½ feet, 15 bbls., pumping.

Nueces County

Luby field: Stanolind Oil & Gas Co. No. 16 Spessard, 5,062 feet, 122 bbls., one-eighth inch choke. Richard King field: Southern Minerals Corp. No. 12 King, perforated casing at 4,010-14½ feet, 101 bbls., three-sixteenths inch choke. Saxet field: Houston Oil Co. No. 15 McGregor, 7,330 feet, 193 bbls., 30 per cent salt water, one-fourth inch choke. Saxet Heights field: Southern Minerals Corp. No. 3 Southern Alkali 6,750 feet, 3,500,000 feet of gas, one-fourth inch choke. West Saxet field: C. Andrade No. 4 Dunn perforated casing 4,075-80 feet, 81 bbls., one-eighth inch choke. Phillips Petroleum Co. No. 1 Funner-Hunter, 6,037 feet, abandoned.

Refugio County

La Rosa field: Darby Petroleum Co. No. 1 Rooke, 6,503 feet, abandoned. Rutherford Oil Corp. No. 1 Schirmer, perforated casing 6,322-26 feet, 151 bbls., one-eighth inch choke. Tomoconnor field: Copano Oil Co. No. 33-B O'Connor, sand 5,871-94 feet, 605 bbls., one-fourth inch choke. Quintana Petroleum Co. No. 27 Heard, perforated casing 5,870-78 feet, 1,333 bbls., three-eighths inch choke. Quintana Petroleum Co. No. 74-A O'Connor, perforated casing 5,881-89 feet, 715 bbls., one-fourth inch choke. Quintana Petroleum Co. No. 2 Williams, perforated casing 5,904-12 feet, 1,322 bbls., three-eighths inch choke. Union Producing Co. No. 5-A Lambert, 6,554 feet, abandoned.

San Patricio County

East White Point field: Texas Co. No. 2 Brigham, perforated casing 5,658-65 feet, 125 bbls., one-eighth inch choke.

Starr County

Sacatosa field: Sinesa Oil Co. No. 1 Salinas, 1,808 feet, abandoned.

Victoria County

Telferner field: Western Gulf Oil Co. No. 2 Beck, 3,-

(Continued on Page 237)

Texas and Louisiana Gulf

By
NEIL WILLIAMS

Two Conroe Trend Tests Are Showing Into Pool Openers

HOUSTON, Tex., Nov. 14.—Production tests were scheduled to be made on two promising wildcats which have shown indications of opening oil fields along the Texas and Louisiana sectors of the Gulf Coast region. These tests are along the Conroe trend in Montgomery County, Texas, and in Terrebonne Parish, Louisiana.

Housh & Thompson were moving in casing to No. 1 E. B. Clary, a wildcat northwest of the Conroe field in Montgomery County, which last week showed evidence of commercial production from the Conroe sand on a drill-stem test at 4,736-39 feet, total depth. The Conroe sand section was reported topped at 4,733 feet, and the first three feet carried gas and the bottom three feet was logged as oil sand. Casing is expected to be cemented to the top of the sand section, and another core will probably be cut before the well is tested. This well topped the Cockfield formation at 4,490 feet, and tested 650 pounds of working pressure in the upper section at 4,514-52 feet. It is generally believed that the well is located on a small structure and leasing has been confined to a rather small area.

In the Hungerford area, Wharton County, Humble Oil & Refining Co. No. 1 Duncan, in the A. Edgar Survey, has attracted much attention due to an attempted blowout. The well is bottomed in sand with no showings at 7,707 feet, and the crew has had to use heavy commercial mud to bring the well under control. The strong gas pressure came as a surprise as none of the upper sands were logged as carrying gas.

Locations for two important wildcats were announced. In the Cypress area, Harris County, C. L. Dobbins and others are preparing to spud No. 1 Ridgeview Farms, in the D. Steele Survey, a projected 6,500-foot test. In the Pearland area, Brazoria County, Carroll Oil Co. and others were preparing to spud No. 1 N. A. Means, on a 5-acre tract in the T. J. Green survey, about a half mile southeast of a dry hole.

In the Clam Lake field, Jefferson County, Shell Petroleum Corp. was preparing to test No. 3 McFaddin, 957 feet southwest of the discovery well. The hole is bottomed at 6,766 feet with 7-inch casing cemented at 6,057 feet. Casing will be perforated in the sand section at 5,997-6,018 feet.

The east side of the Hitchcock field, Galveston County was defined with the abandonment of Maco Stewart No. 8 fee, at a total depth of 5,183 feet. Southwest of production about a mile and located in the Arthur Burke Survey, Wittjen Oil Co. No. 1 Coon was preparing to spud.

Midway between the discovery well of the Francitas field and the townsite of Francitas, Crosby Drilling Co. has spudded No. 1 John Broughton. The well is being drilled on a farmed-out lease from The Texas Co. and is in the center of lots 44 and 45, Block 6, Patrick Green Survey. The discovery well was completed as a distillate producer in the Frio formation at 7,460-65 feet.

South Louisiana

On the South Houma prospect, Terrebonne Parish, Shell Petroleum Corp. was running tubing preparatory to testing No. 1 Peters, after 7 stands of 36-gravity oil and 6 stands of oil-cut mud was recovered on a 10-minute drill-stem test through perforated casing at 10,300-05 feet. The bottom 4 stands held muddy salt water. This test is in Section 73-18s-18e, and was drilled to 11,047 feet, where a stuck drill stem halted drilling.

In the Bancroft field, Beauregard Parish, Republic Production Co. No. 2 Lutcher-Moore, Section 16-6s-13w, one-half mile north of the discovery well, was flowing into the burning pits, but no gauge was available. The well was completed through perforated casing at 7,265-73 feet, but was killed to rework due to a high gas-oil ratio. West of the discovery well, the same company's No. 2 Columbia Land & Timber Co., perforated casing at 7,294-99 feet, but final completion has been held up due to a fishing job. Locations were made for No. 3 Lutcher Moore Lumber Co. and No. 3 Columbia Land & Timber Co. both in Section 16.

Texas Co. staked location for a third test in the Bateman Lake field, St. Mary Parish. The well is No. 2 State Bateman Lake in Section 21-16s-12e. Preparations were made to test No. 1 Wax Bayou which is bottomed at 11,185 feet, with 7⅝-inch casing cemented at 11,126 feet.

In the Baton Rouge field, East Baton Rouge Parish, William Helis No. 3 Duplantier, Section 65-7s-1w, has been killed due to salt water intrusion. This well was drilled to a total depth of 6,820 feet, and was tested through perforated casing at 6,775-78 feet. Oil sand was logged at intervals from 6,474 to 6,779 feet, and the well flowed pipe line oil before salt water broke in.

New Pay at Bayou Des Allemands

A new sand was opened at the Bayou Des Allemands field, St. Charles Parish, by the completion of Amerada Petroleum Corp. No. 1 Gheens Realty Co., Section 56-15s-20e. Casing was perforated at 7,239-54 feet, and the well flowed 83 bbls. in 3 hours through a quarter-inch choke.

The second producer completed on the Jefferson Island Dome, Iberia Parish was Texas Co. No. 1 State-Lake Peigneur, which flowed 252 bbls. per day through a 10/64-inch choke. Production was obtained by perforating the casing at 7,827-37 feet. The well is producing above the salt, topped at 7,880 feet, and was drilled to a total depth of 7,897 feet.

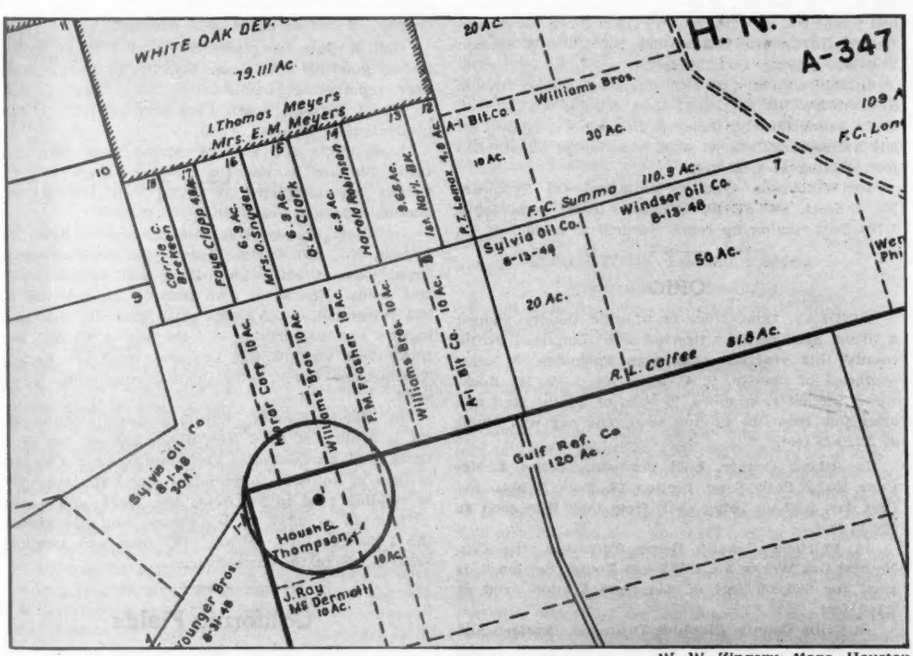
In the Lake Barre field, Terrebonne Parish, Texas Co. No. 21 State, opened distillate production from a 10,000-foot horizon when it was completed for an initial production of 20 bbls. of distillate and 3,000,000 feet of gas daily. The well is flowing through perforated casing at 10,460-520 feet.

Plaquemines Parish

On the Venice dome, Plaquemines Parish, Tidewater Associated Oil Co. was completing No. 2 Buras Levee Board which is expected to open another new sand. The sand section was topped at 3,541 feet and 7-inch casing was cemented at 3,619 feet, after the hole was cored to a total depth of 3,634 feet.

Texas Co. No. 1 La Terre, on the Golden Meadows prospect, La Fourche Parish, failed to flow on a second production test through perforated casing at 9,265-90 feet, and the perforations have been squeezed off to make another test. This well produced distillate on a recent test at 8,562-68 feet. Several promising sands are reported to have been cored.

In the Lake Long field, La Fourche Parish, Fohs Oil Co. was attempting to open another new sand with the testing of No. 6 Lake Long, 1,320 feet northeast of No. 5 Lake Long, which is producing at 10,232-36 feet. No. 6 Lake Long is standing cemented with 7-inch casing on bottom and the well will test a good sand section topped at 9,312 feet and cored at intervals to the total depth.



W. W. Zingery, Maps, Houston

Housh & Thompson were moving in casing preparatory to testing No. 1 E. B. Clary, northwest of the Conroe field. A drill stem test gave evidence of production

COMPLETIONS ON TEXAS GULF COAST

(24-hour production)

Brazoria County

Manvel field: Texas Co. No. 27-B Belcher, sand 5,000-5,135 feet, 170 bbls., one-fourth inch choke. West Columbia field: Texas Co. No. 4 Goldman, sand 5,531-5,360 feet, 499 bbls., one-fourth inch choke. D. M. Wallace No. 3 T. L. Smith sand 5,538-5,626 feet, 491 bbls., one-fourth inch choke.

Chambers County

Anahuac field: Humble Oil & Refining Co., No. 2-B Middleton, 7,100 feet, 240 bbls., one-fourth inch choke.

Galveston County

Dickinson field: Coast Petroleum Co. No. 11 Maco Stewart, top sand 8,573 feet. Total depth 8,812 feet, 720

(Continued on Page 237)

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THE OIL AND GAS JOURNAL

Illinois Fields

(Continued from Page 219)

so the pay sand is geologically deeper than any other pay yet found in the basin.

In Cumberland County, National Consumers Oil Co. No. 1 Harrison-Ward, NE SE NE Section 17-9n-9e, was shut down at 2,070 feet.

In Shelby County, Black and others No. 1 Hopkins, SE NW SE Section 1-9n-4e, had tools moved in; Frank Frederick and others No. 1 Fluge, near C N half NE NW Section 34-10n-5e, spudded; Refiners & Producers No. 1 Darst, NW NW NW Section 17-11n-2e, derrick; Frank Piggott and others No. 1 Swiney, NW NW SW Section 10-11n-5e, derrick; W. S. Tatum No. 1 Harper, SW NW SE Section 8-12n-2e, derrick; Independent Refiners & Producers No. 1 J. Hackenburg, SE SW SW Section 20-12n-2e, drilling at 580 feet; Prunty Production Co. No. 1 Hickey, C SE SW SW Section 34-12n-4e, shut down at 1,665 feet.

In Macoupin County, Phillips Petroleum Co. No. 1 Giller, 1,028 feet from E and 330 feet from N lines of NW quarter Section 15-11n-8w, had Devonian lime top at 1,237 feet, water at 1,255-60 feet, and was drilling at 1,333 feet.

In Coles County, Ed Swearer and Crown Petroleum Co. No. 1 Sanders, SE SE NW Section 27-13n-8e, was drilling at 250 feet.

In Champaign County, Sidney Oil & Gas Co. No. 1 Wendling, 1,570 feet from S and 450 feet from E line SE quarter Section 10-17-10e, was spudded; Barber & Seiver No. 1 Lindsey, C NW SE Section 20-20-8e, drilling at 580 feet.

In Jefferson County, V. O. Lewis No. 1 Bates, NE cor. NE NW Section 18-1s-1e, had a showing of oil at 972-80 feet and was drilling at 980 feet.

In Edgar County, the McNamara Construction Co. No. 1 Blair, NW NE NW Section 24-14n-14w of first meridian, was drilling at 500 feet.

In Edwards County, Leach Brothers No. 1 Lee, SW NE SE Section 11-1s-10e, was fishing at 3,985 feet.

In Wayne County, Robinson and others No. 1 Acola, 220 feet from N and 1,520 feet from W lines of NW quarter Section 31-2s-6e, was drilling at 2,040 feet; L. W. Dennis No. 1 Fred Dickey, NW cor. NW SE Section 26-2s-7e, set 10-inch casing at 150 feet; Dr. Moore No. 1 Moore, SE NE NW Section 16-3s-5e, drilling at 2,125 feet; H. H. Weinert No. 1 Hamilton, C S half SE NW Section 32-3s-7e, drilling at 2,225 feet.

In Jefferson County, W. O. Allen No. 1 Puckett, NE NW NW Section 12-3s-2e, shut down for orders at 1,890 feet; Magnolia Petroleum Co. No. 1 Dore, 330 feet from S and 990 from W lines of NE quarter Section 12-3s-2e, McClosky lime at 2,725 feet, coring ahead.

In Randolph County, Cain and others No. 1 Smiley, SE SE NW Section 31-4s-5w, total depth 1,750 feet, had a hole full of water and was shut down for orders; Badger Oil Co. No. 1 Schroeder, SE NW NW Section 27-6s-6w, drilling at 1,750 feet.

In White County, Sun Oil Co. No. 1 Robert Brown, C N half SW NW Section 12-4s-9e, drilling at 2,210 feet.

In Saline County, Bailey & Lucas No. 1 Logan, SE NE NE Section 21-8s-8e, small showing of oil at 1,345 feet, drilling at 1,425 feet.

In Williamson County, Geological Oil Syndicate No. 1 Scott, SW SE SW Section 4-10s-2e, total depth 1,790 feet, rigging up rotary to drill to 3,000 feet.

OHIO

FINDLAY, Ohio, Nov. 14.—Lorain County yielded a 70-bbl. producer, the first oil well completed in the county this year. In Lagrange Township, 3 miles southeast of Oberlin, R. C. Kane No. 1 W. W. Rockwood, Section 1, swabbed 70 bbls. of oil the first day after shot from the Clinton sand. The pay was found at 2,220-25 feet.

In Athens County, Lodi Township, Gross & McCune No. 2 Pearl Sapp, Section 13, made 8 bbls. the first day, without being shot, from Cow Run sand at 426-33 feet.

In Fairfield County, Berne Township, the City Natural Gas Works No. 1 William Young, Section 6, is good for 260,000 feet of gas from Clinton sand at 2,145 feet.

In Gallia County, Cheshire Township, Brannen and others No. 1 J. I. Swisher, Section 14 is a small second Berea gas well at 1,622 feet.

In Guernsey County, Washington Township, Jones & Jewell No. 1 L. E. Lewis, Section 14, had a small showing of gas in the Berea sand at 1,263 feet. It was abandoned after testing.

In Licking County, Licking Township, McClay Brothers No. 1 Vernon Pruce, Section 3, was drilled to 2,752 feet and abandoned. Both the Newburg and the Clinton sands were dry. In Mary Ann Township, Armbruster and others No. 2 E. H. Davis, Lot 8, fourth quarter, made 10 bbls. of oil the first day after a shot in Berea sand at 695-705 feet.

In Meigs County, Salisbury Township, W. G. Reed and others No. 2 Martha Hysell, Section 33, is good for 800,000 feet of gas from salt sand at 948 feet and Maxon sand at 1,055 feet.

In Morgan County, Homer Township, D. T. Orndoff No. 2 Sarah V. Dale, Section 2, has an open flow of 100,000 feet of gas from second Berea sand at 1,592 feet.

In Noble County, Wayne Township, Yorker Valley Oil & Gas Co. No. 1 J. L. Dollison, Section 28, made 300,000 feet of gas from the Berea at 1,506 feet.

In Stark County, Lawrence Township, Obermiller Brothers No. 1 George Gill, Section 12, is a gas well making 500,000 feet from the Clinton sand at 4,143-72 feet.

In Washington County, Barlow Township, Anderson and others No. 2 C. W. Greenlees, Section 4, is a gas well gauging 150,000 feet from the Injun sand at 1,473-78 feet. In Marietta Township, Hupp & Yerian No. 10 Washington County Infirmary, Section 11, had a small showing in the Mitchel sand at 528-40 feet. A shot did not increase the flow and well was abandoned.

Lima Field

In the Tiffin area, Seneca County, Clinton Township, Charles Shaull completed a small gas well on the William Weinbarger tract a few hundred feet north of the north corporation line of the city. The top of the Trenton was found at 1,466 feet, total depth 1,566 feet. In the same township, Sun Oil Co. is setting a liner in the Green sand on its No. 1 F Zeis; will be drilled deeper from 2,091 feet. In Pleasant Township, Jones & Keener No. 25 F. D. Sours, are working with the casing at 2,051 feet before drilling into the Green sand.

In Wood County, Portage Township, Goodwill Oil & Gas Co. No. 1 Lester Shinew, Section 5, hit the Trenton lime at 1,229 feet and drilled to 1,230 feet; it is shut down. A small showing of gas was found in the top of the Trenton; the hole may be deepened.

EASTERN KENTUCKY

ASHLAND, Ky., Nov. 14.—A number of completions are included in the Eastern Kentucky activities this week with operations seemingly on the upgrade.

Caldwell & Crabtree report the completion of No. 2 Lula Law at Pilot in the South Fork district of Powell County. It started at 10 bbls. per day.

Hall & Ogle completed No. 1 at Pilot in Powell County good for 5 bbls. per day. Joe T. Brown, treasurer, reports the completion of No. 4 Lowery Heirs at Mount Springs, South Fork district, with a daily production of 5 bbls. of oil.

Rush Cable No. 9 E. S. Moore tract No. 1 on Little Sinking in the Big Sinking district in Lee County was completed as an oil well, but the production was not available.

In Knott County, Inland Gas Corp. is down 672 feet in No. 203 Curtis Pigman, on Right Fork of Troublesome Creek with drilling continuing in slate and shells. The same firm made a location for No. 204 Virginia-Kentucky Gas Co. land in the same locality and was drilling at 1,488 feet in No. 205 Kentucky-West Virginia Gas Co. land, on Trace Fork of Troublesome Creek, with drilling continuing in salt sand.

In Martin County, Kentucky-West Virginia Gas Co. is drilling at 1,395 feet in No. 5191 on the W. R. Crum land, on Coldwater Fork, and is down 1,910 feet in lime in No. 5246, John Salyer land. The same firm is building road to No. 5249, Alie Ward, and moving to location of 4235, C. W. Preece, and has reached the 1,156-foot level in No. 574, John and Benjamin Sellards, all in the same district.

California Fields

(Continued from Page 230)

flowing 358 bbls. of clean 24.1-gravity oil daily from 4,983 feet after the hole had been carried down to 5,100 feet and then plugged back. Franco Western Oil

TANKER SHIPMENTS FROM LOS ANGELES TO DOMESTIC AND FOREIGN PORTS

	November 5		October 28			
Intercoastal-domestic—	Total this week	Daily average	Total last week	Daily average	This year to date	Same time last year
Crude oil	.....	.....	.....	.....	852,826	129,788
Diesel and gas oil	.....	.....	.....	.....	.....	176,726
Gasoline	.....	.....	.....	.....	2,631,841	3,666,922
Kerosene	.....	.....	76,621	10,946	333,626	328,907
Foreign exports—						
Crude oil	643,091	91,870	486,276	69,468	18,797,054	13,309,660
Fuel oil	235,549	33,650	192,296	27,471	7,854,897	12,307,115
Diesel and gas oil	.....	.....	177,699	25,386	5,118,356	6,633,503
Gasoline	356,400	50,914	140,463	20,063	6,954,602	6,673,733
Kerosene	49,362	7,052	33,338	4,763	945,528	1,967,922
Lubricants	.....	.....	2,172	310	175,560	12,984
Other unfinished oil	.....	.....	.....	.....	.....	974,785
Coastwise-domestic—						
Crude oil	117,608	16,801	114,316	16,331	10,017,543	4,807,622
Fuel oil	238,194	34,028	464,054	66,293	10,365,286	13,428,436
Diesel and gas oil	25,139	3,591	14,201	2,029	1,322,288	1,968,346
Gasoline	320,814	45,831	184,235	26,319	12,623,781	13,443,300
Kerosene	.....	.....	2,074	296	210,640	368,080

TANKER SHIPMENTS FROM SAN FRANCISCO TO DOMESTIC AND FOREIGN PORTS

Intercoastal-domestic—						
Diesel and gas oil	.....	.....	.....	.....	196,644	222,330
Gasoline	.....	.....	.....	.....	25,409	25,778
Kerosene	.....	.....	.....	.....	16,124	72,750
Asphalt	.....	.....	.....	.....	490,039	413,885
Lubricants	.....	.....	.....	.....	19,945	25,522
Foreign exports—						
Crude oil	151,845	21,692	.....	.....	4,740,491	2,831,674
Fuel oil	27,061	3,866	.....	.....	2,288,614	1,789,632
Diesel and gas oil	303,945	43,421	138,549	19,793	2,866,135	2,593,788
Gasoline	62,268	8,895	.....	.....	4,788,805	4,545,902
Kerosene	.....	.....	.....	.....	696,099	823,159
Asphalt	.....	.....	.....	.....	56,258	.....
Lubricants	40,112	5,445	.....	.....	525,679	474,494
Coastwise-domestic—						
Fuel oil	276,277	39,468	136,622	19,517	5,418,447	5,464,320
Diesel and gas oil	33,168	4,738	53,549	7,650	1,352,472	1,233,280
Gasoline	113,760	16,251	184,916	26,417	6,753,708	4,878,374
Kerosene	25,932	3,705	35,844	5,121	542,778	338,174

Co. No. 16 in Section 8-30-22 was good for 338 bbls. of 16.6-gravity oil cutting 10 per cent upon completion at 2,516 feet when put on the beam. Helm & Smith completed another small shallow well in the Kern River field this week when No. 10-A was brought in pumping 18 bbls. of 14.4-gravity oil cutting 9 per cent per day from 682 feet.

Kettleman North Dome

Kettleman North Dome Association finished an excellent producing well in the Kettleman North Dome field when No. 36-16-Q in Section 16-22-18 was turned loose following completion in the Temblor at 8,140 feet. It came in flowing 7,492 bbls. of very clean 36.4-gravity oil and 7,521,000 feet of gas per day.

In the Rincon field of Ventura County, Chanslor Canfield Midway Oil Co. completed No. 23-B Hobson flowing 374 bbls. of clean 29.9-gravity oil and 177,000 feet of gas per day from 4,092 feet. This new well was finished with 142 feet of 6⅝-inch liner including 73 feet of 120-mesh landed on bottom. In the Santa Maria Valley field, Hancock Oil Co. and R. R. Bush Oil Co., which are jointly developing productive acreage, have concluded drilling operations for the next several months. Late this week they completed No. 4 Bradley Lands flowing 210 bbls. of clean 16.4-gravity oil per day from 4,855 feet. In the Ventura Avenue field, Shell Oil Co. has completed No. 30 Edison flowing 75 bbls. of 25.5-gravity oil per day on gas lift from 7,520 feet. The initial daily production showed a cut of about 18 per cent but appears to be cleaning up in good shape.

Gulf Coast Fields

(Continued from Page 235)

bbls., one-fourth inch choke. J. K. Hughes No. 4 J. C. Ecret sand 8,930-75 feet, 649 bbls., one-fourth inch choke. Hitchcock field: Maco Stewart No. 8 fee 5,183 feet, abandoned.

Harris County

Clear Lake field: West Producing Co. No. 1-B West, 5,941 feet, abandoned. Fairbanks field: Amerada-Stanolind Oil & Gas Co. No. 3 W. E. Denman, sand 6,815-43 feet, 606 bbls., one-fourth inch choke. Amerada-Stanolind Oil & Gas Co. No. 4 E. W. Mills, sand 6,823-54 feet, 447 bbls., one-fourth inch choke. Bridwell Oil Co. No. 2 Gipson, sand 6,800-55 feet, 125 bbls., one-eighth inch choke. Sinclair Prairie Oil Co. No. 1 Goodykoontz, perforated casing 6,948-57 feet, 23,500,000 feet of gas. H. E. Williams No. 1 Deacon, perforated casing 6,838-42 feet, 621 bbls., one-fourth inch choke. Friendswood field: Humble Oil & Refining Co. No. 20 Beamer, sand 5,718-6,042 feet, 606 bbls., one-fourth inch choke. Humble Oil & Refining Co. No. 1 J. E. Fleming, 6,135 feet, abandoned. Humble Oil & Refining Co. No. 15 Gray, 6,037 feet, 624 bbls., one-fourth inch choke. Humble Oil & Refining Co. No. 7 A. B. Kiesling, sand 5,707-6,040 feet, 576 bbls., one-fourth inch choke. Humble Oil & Refining Co. No. 4 J. H. Ross, 6,044 feet, 576 bbls., one-fourth inch choke. Tomball field: Humble Oil & Refining Co. No. 8 Faris, 5,561 feet, 72 bbls., one-fourth inch choke. Humble Oil & Refining Co. No. 5 Hoffman, 5,553 feet, 240 bbls., one-fourth inch choke. Humble Oil & Refining Co., No. 8 Mary Keuhn, sand 5,548-62 feet, 466 bbls., one-fourth inch choke.

Jefferson County

Amelia field: Stanolind Oil & Gas Co. No. 4 J. W. Hall, sand 5,879-86 feet, 13 bbls., one-fourth inch choke. Cheek field: Shell Petroleum Corp. No. 1 Ed. Pleasant, perforated casing 7,718-22 feet, 106 bbls., 11/64-inch choke. Spindletop field: Stanolind Oil & Gas Co. No. 102 Gladys City, perforated casing 3,022-42 feet, 313 bbls., one-fourth inch choke.

Liberty County

Hardin field: Tidewater Associated Oil Co. No. 3 Cessna, top sand 7,588 feet, total depth 7,610 feet, 524 bbls., one-fourth inch choke.

Matagorda County

Bay City field: Hamman Exploration Co. No. 3 J. H. Crooker, perforated casing 8,115-60 feet, 176 bbls., various chokes.

Wharton County

Magnet field: Atlantic Refining Co. No. 8 Cockburn, 5,544 feet, 134 bbls., one-eighth inch choke. Gray & Wolfe No. 1 State, sand 5,565-34 feet, 59 bbls., 3/32 inch choke. Pickett Ridge field: Texas Co., No. 2 Tiustos, 4,606 feet, abandoned. Gilcrease Oil Co. No. 1 Baston, 4,688 feet, 267 bbls., three-sixteenths inch choke. Withers field: Smith & McDannald, No. 1 Jordan, 5,545 feet, 122 bbls., one-eighth inch choke. Texas Co., No. 23 Pierce Estate, 5,547 feet, 67 bbls., one-eighth inch choke.

Southwest Texas Fields

(Continued from Page 234)

653 feet, abandoned. Western Gulf Oil Co. No. 3 Beck, 3,024 feet, abandoned.

Sun Field Extended

A half mile north extension to the Sun field, Starr County, was indicated by Circle Oil Co. No. 1 Olivarez, Section 241. Sand with an oil odor was cored at 4,559-60 feet, shale at 4,560-61 feet and sand showing oil at 4,561-73 feet. On a drill stem test at 4,560-73 feet, 425 feet of pipe line oil was recovered and the pressure built up to 90 pounds in 8½ minutes. This is a new sand for the field and indicates that the main part of the structure extends north from the discovery well in view of the dry hole recently drilled by Sun Oil Co. on the Speer lease, one half mile south of the discovery well in Section 274. This well ran considerably lower than the discovery well and was quit at a total depth of 6,131 feet. One half mile northeast of the discovery, Sun Oil Co. No. 1 Olivarez, Section 239, is drilling in sandy shale at 5,572 feet. This test has logged three promising oil sands, and 7-inch casing was recently cemented at 5,242 feet.

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Kansas Developments

By
DAL DALRYMPLE

Productive Areas Opened in Russell and Rooks Counties

Two new producing areas were uncovered in Kansas the past week, while extensions were given several other fields. The new areas were in Rooks and Russell counties. Nineteen producing wells in the state were completed.

Western Kansas Oil & Refining Co. No. 1 Schneider, NE NE NW Section 35-15-14w, about 12 miles south of Russell in Russell County, was completed for potential of 1,861 bbls. of oil, following three-stage acid treatment with 5,000, 1,000 and 2,000 gallons. It topped Arbuckle dolomite at 3,346 feet and was bottomed at 3,353 feet. The area opened by this outpost has been designated the Schneider pool. It is three-fourths mile south of the Ochs pool and 1 mile northwest of the Trapp field. Location is on an Ohio Oil Co. farmout. Cities Service Oil Co. will be required to drill two offsets, with one offset by Phillips Petroleum Co. required.

The Rooks County pool opener was the Texokana Oil Co. No. 1 Fyke, SE NE SW Section 9-19-17w, some 4 miles northeast of Plainville. After the hole filled with water from Arbuckle dolomite at 3,504-07 feet, total depth, it was plugged back to 3,352 feet in Lansing-Kansas City lime. After treating with acid, it produced 39 bbls. of oil daily, with some water.

Extension Producers

Indian Territory Illuminating Oil Co. No. 1-B Peters, NW cor. Section 13-20-11w, outpost one-half mile north of the South Silica pool in Barton County, found Arbuckle formation at 3,272-74 feet, total depth, and was due for completion. Seven-inch casing was set at 3,272 feet. It is three-fourths mile southwest of the Barton County sector of the Silica field.

Extension of the Eichman pool in Russell County three-fourths mile northward appeared imminent at W. I. Southern, Inc., No. 1 Sellens, SW cor. Section 22-15-13w. Saturation was found in Lansing lime cores from 3,150-3,167 feet, spotted saturation in a core from 3,178 feet, and a small showing of oil was found in 1½-foot recovery from 3,178-3,186 feet. Operators were coring below 3,331 feet. The Southern company owns the south and southwest offset locations, and Cities Service Oil Co. has the west offset.

Western Kansas Oil & Refining Co. No. 1 Keil, NE NW NW Section 6-15-13w, found Lansing lime at 2,881 feet and cored saturation from 2,804-2,912 feet. The crew was preparing to shoot after drilling plug set in 7-inch casing at 2,903 feet. Location is on an Ohio Oil Co. farmout, one-half mile north of the Hall pool in Russell County.

Yankey-Stearns No. 6 Krug, NW SE NW Section 7-15-13w, three-fourths mile northwest of the Coralena pool in Russell County, was due to drill plug in 7-inch casing set on top of Lansing lime at 3,034 feet. Total depth was 3,046 feet in lime.

Rooks County Outpost

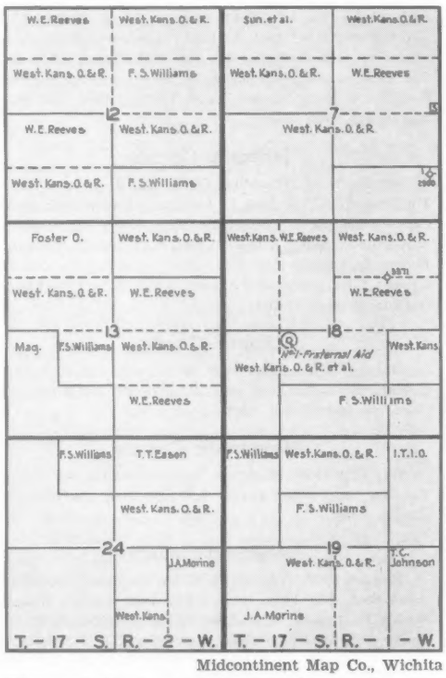
Phillips Petroleum Co. No. 1 Tanzey, C NW SW Section 25-8-18w, wildcat, 7 miles south of Stockton and 1 mile northwest of the Dopita pool in Rooks County, topped Arbuckle formation at 3,418 feet and found saturation in a core from 3,420-23 feet. Pipe was stuck at 3,025 feet and the crew was circulating oil in the hole in an attempt to free it. Wells in the nearby Dopita pool are producing from Lansing and Arbuckle horizons.

Phil-Han Oil Co. No. 1 Weimeister, SW Section 18-14-13w, on a Texas Co. farmout 1 mile northeast of the South Gurney pool in Russell County, topped Topeka lime at 2,640 feet, had oil showing in that formation at 2,655-65 feet, and the crew was drilling ahead below that depth. Previously, it topped Tarkio lime at 2,305 feet and was estimated good for 50 bbls. of oil daily from that formation at 2,340-47 feet.

Kansas operators were interested in C. L. Carlock and others No. 1 Smith, C SW SE Section 11-17-25w, wildcat 12 miles northwest of Ness City in Ness County, as it drilled below 4,045 feet. Nearest production is in the Aldrich pool, productive from Mississippi lime, some 6 miles to the southwest. Location is on a Carter Oil Co. farmout.

Kingman County Discovery

Bunte Brothers and Jock Garden No. 1 Shepherd, SE cor. Section 10-27-10w, wildcat pool opener northeast of the Cunningham field in Kingman County, was testing on the pump. It topped Lansing lime at 3,609



Midcontinent Map Co., Wichita

Western Kansas Oil & Refining Co. uncovered production at a wildcat in Section 18-17-1w

feet, drilled to 4,529 feet, plugged back to 4,086 feet and, prior to treating with acid, pumped 75 bbls. of oil naturally.

New Operations

Lawrence Spencer and Frank Phelps No. 1 Myers, NW SE Section 29-30-5, east offset to the discovery producer in the Dunbar pool, Cowley County, was a machine. The Dunbar discovery well is producing from Lansing lime. The No. 1 Myers also offsets a dry hole, drilled as a twin well to the discovery.

Campbell Drilling Co. No. 1 Union Central, SW NW Section 28-30-3, is location for a test southwest of production in the Udall pool, Cowley County.

Cities Service Oil Co. started work at No. 1-B Hall, C NW Section 2-12-17w, 1¾ miles south of production in the Bemis field, Ellis County.

E. B. Shawver and Darby Petroleum Corp. No. 1 Peavy, NW NE Section 24-11-18w, wildcat 1½ miles south of the South Burnett pool, Ellis County, had started work.

Tom Palmer No. 1 Miller, NW SW SW Section 3-16-12w, one-half mile east of the North Beaver pool in northern Barton County, was building rotary derrick. Sinclair Prairie Oil Co. No. 1 Prusa, SE cor. Section 20-16-11w, southeast of the Davidson pool, Barton County, was a rotary rig. Western Kansas Oil & Refining Corp. No. 1 Lowry, CWL SW Section 2-17-13w, one-half mile east of the Ainsworth pool, Barton County, was building rotary rig. It is one-fourth mile south of a dry hole. Web-Son Oil & Royalty Co. and Virginia Drilling Co. No. 1 Clawson, SW NW Section 17-20-11w, outpost south of the South Ellinwood pool, had begun work.

Monarch Royalty Co. No. 1 Central Life, CEL W half NW Section 17-20-11w, wildcat southwest of the Big Sandy area in Woodson County, was drilling below 765 feet.

Estimated Daily Production

Estimated daily production for Kansas for the week ending November 12, and for the preceding week, was as follows:

	Barrels	
	Nov. 12	Nov. 5
Oxford City	1,075	1,175
Burrton	9,550	8,475
Ritz-Canton	4,225	4,200
Graber	2,675	2,575
Hollow-Nikkel	1,725	1,700
Lerado	850	825
Voshell	1,825	1,875
Wellington	2,250	2,175
Ellsworth County:		
Lorraine	2,075	2,025
Other pools	2,125	1,135
Rice-Barton counties:		
Bloomer	1,850	2,325
Chase	4,000	4,025
Geneseo	3,275	3,225
Raymond	825	1,025
Silica	8,150	10,625
South Silica	1,400	1,600
Keesling	700	775
Wherry	3,325	2,625
Miscellaneous Barton	6,400	6,100
Miscellaneous Rice	6,125	6,025
Russell County	21,275	19,575
Sedgwick County	3,750	3,775
Ellis County:		
Bemis	5,675	4,275
Miscellaneous	2,305	2,205
Kingman County	680	675
Stafford County	4,100	3,970
Greenwood County	9,200	9,250
Butler County	19,150	18,675
Other fields	17,515	17,690
Total Kansas	148,075	144,600

McPherson Discovery

Western Kansas Oil & Refining Co. and others No. 1 Fraternal Aid, NW NE SW Section 18-17-1w, wildcat strike in northeastern McPherson County was to be treated with acid before testing. It had 1,800 feet of oil in the hole, coming from chat at 2,687 feet, total depth. The crew was pulling the big pipe.

George P. Dickey and associates No. 1 Carlson, SE SW NW Section 24-19-3w, produced 20 bbls. of oil an hour on preliminary tests from chat at 2,992 feet, total depth. It is in the south end of the Chindberg pool, McPherson County.

In Sumner County

S. A. Murphy and others No. 1 Tate, SE NW Section 31-32-2e, which opened a Wilcox sand area southwest of Oxford in Sumner County several weeks ago, was reported abandoned after deepening to Arbuckle lime. Initial yield was 353 bbls. of oil in 24 hours from Wilcox sand at 3,740 feet. Production declined and operators decided to deepen. The Arbuckle zone was found at 3,752 feet and the hole filled with water at 3,763 feet.

Cameron, Spencer and others No. 1 Frey, NW cor. Section 5-30-1e, wildcat northeast of the Zyba pool, found Stalnaker sand at 2,460 feet, some water intruded at 2,485 feet, and the crew was drilling ahead below 2,650 feet.

Wentworth and others No. 2 Latta, SE NE Section

8-30-2w, on the west side of the Latta pool, topped Kansas City lime at 3,045 feet, took a saturated core from 3,060-65 feet, and was bottomed at 3,089 feet. Casing was being run preparatory to drilling in.

Northern Wildcats

J. A. Turner and Saco Oil Co. No. 1 Umshide, C NE NW Section 32-8-9, wildcat north of the town of Flush in Pottawatomie County, northeastern Kansas, was reported shut down after finding granite at 1,985 feet.

Babcock Oil Co. and others No. 1 Copeman, CNL S half S half SE Section 7-10-2w, wildcat northeast of Minneapolis in Ottawa County, found chat at 2,670 feet and was drilling below 2,750 feet, with nothing reported showing.

Wildcat in Saline

Central States Oil Co. of Wichita was drilling below 1,100 feet in shale at No. 1 J. L. Crawford, NW SW NE Section 26-13-3w, wildcat in Saline County. Location is on a Carter Oil Co. seismograph structure.

Harvey County Outpost

Derby Oil Co. and E. K. Carey drilling Co. No. 1 Jones, CEL NE NW Section 7-22-1w, wildcat 1½ miles northeast of the Sperling pool in Harvey County, was drilling out cement plug at 3,279 feet in Misener sand after recovering a 7-foot saturated core in that formation. It also had a showing of oil in Hunton lime, topped at 3,289 feet.

Establish Potentials

Several recently completed Kansas wells were given potential rating by the Corporation Commission, as follows:

In Barton County, Stanolind Oil & Gas Co. No. 11 Kowalsky, C N half S half NE Section 11-20-11w, Silica field, 1,991 bbls. of oil in 24 hours from Arbuckle lime at 3,293 feet.

In Ellsworth County, Watchorn Oil & Gas Co. No. 2 Braun, NW NE SE Section 3-14-17w, in the Toulon area, was acidized in Arbuckle lime at 3,512 feet and made potential of 589 bbls. of oil.

In Rooks County, Vickers Petroleum Co. No. 1 Luhman, NW NW SE Section 11-9-16w, Laton pool, was rated at 1,991 bbls. of oil in 24 hours from Arbuckle lime at 3,315 feet. It was acidized.

In Barton County, Phillips Petroleum Co. No. 7 McClanahan, NE SW SE Section 7-16-13w, South Trapp pool, 1,308 bbls. of oil in 24 hours from Arbuckle lime at 3,366 feet. Stanolind Oil & Gas Co. No. 3 Redtzke, SE Section 26-16-13w, Ainsworth pool, 368 bbls. of oil in 24 hours from Arbuckle lime at 3,395 feet.

In Ellis County, Shell Petroleum Corp. No. 16 Rumsey, SE SE NW Section 23-11-17w, Bemis field, 2,914 bbls. of oil daily from Arbuckle lime at 3,422 feet.

In McPherson County, Jess Cling No. 1 Unruh, C NE SE Section 26-19-2w, Ritz-Canton field, 120 bbls. of oil in 24 hours from chat at 2,975 feet, acidized.

In Reno County, Olson Oil Co. No. 5 Duckworth, NE NW NE Section 23-23-4w, Burrton field, 29 bbls. of oil daily from chat at 3,375 feet.

N. Y.-Penna. Gas Fields

COUDERSPORT, Pa., Nov. 12.—There were no completions during the past week in the deep sand gas fields of New York and northern Pennsylvania but two new locations were added, bringing the total of current operations in these fields to 28, the highest in some time.

Both new locations are for wildcat tests, New Penn-McKean on the Glenn Taylor farm, Ceres Township, McKean County, and Evjen, Harris and others on the A. R. Mitchell farm, Sweden Township, Potter County.

The wildcat test of McKenry and others on the Stellman farm in Rockland Township, Venango County, is reported down to 4,903 feet. All other Pennsylvania operations are in Potter County. In Bingham Township G. L. Cabot, Inc., is drilling at 5,278 feet on the Frank Raymond farm after topping the Onondaga at 5,295 feet and at 2,200 feet on the Mary Lebar farm, Sylvania Corp., at 2,790 feet on the Roy Harrison farm, and Updegraph and others, at 578 feet on the Fred Whitney farm. In Harrison Township G. L. Cabot, Inc., is drilling at 3,750 feet on the Emma Elliott farm, Hanley & Bird at 4,685 feet on the No. 2 F. Rook where the Tully was encountered at 4,421-69 feet and New York State Natural Gas Co. at 470 feet on the Bennie E. Truax farm. Belmont Quadrangle Drilling Co. is drilling at 2,220 feet on the R. M. Wolcott farm in Sharon Township.

All New York operations with the exception of the Belmont Quadrangle Drilling Co.'s test on the E. A. Treat farm, Erin Township, Chemung County, which is drilling at 2,185 feet, are divided between Steuben County and Allegany County.

In Woodhull Township, Steuben County, G. L. Cabot, Inc. is drilling at 2,840 feet on the Charles Crane No. 1, fishing at 1,629 feet on the Charles Crane No. 2 and rigging up for the George Hotaling No. 2 and Clancey is drilling at 200 feet on the School District No. 5 property. Clancey and others are also drilling at 3,550 feet on the D. Hovey farm and Van Gelder and others, at 972 feet on the Fred Farnham farm, Addison Township; G. L. Cabot, Inc. at 4,420 feet on the Elmer Downey farm, West Union Township, and New York State Natural Gas Co. at 2,210 feet on the Sarah Hammond farm, Troupsburg Township. New York State Natural Gas Co. has also staked a location for a test on the F. Boyd farm in Cameron Township.

Four wells are drilling in Willing Township, most active of the Allegany County areas. Belmont Quadrangle Drilling Co. is drilling at 4,400 feet on the G. Lampe farm after topping the Tully at 4,292 feet; Empire Producing Co., at 2,785 feet on the Dan Clark No. 2; Cunningham Natural Gas Co., at 3,000 feet on the Fortner farm, and Empire Producing Co. is shut down at 402 feet on the Floyd Wilson No. 2. G. L. Cabot, Inc. is drilling at 3,030 feet on the Empire-Rogers farm, Alma Township, and Belmont Quadrangle Drilling Co. at 1,458 feet on the Elin Livermore farm, Independence Township, where it encountered small gas shows at 595, 697 and 863 feet.

Rocky Mountain Fields

Production estimates for week ending November 12, 1938:

WYOMING

	Barrels
Salt Creek	15,680
Big Muddy	1,180

1st NATIONAL

STATEMENT OF CONDITION

At the Close of Business, September 28, 1938

ASSETS

Cash on Hand and Due from Banks	$ 57,333,144.31
United States Securities Owned	22,704,445.88
Stock in Federal Reserve Bank	318,000.00
Other Stocks and Bonds	3,161,547.00
Loans and Discounts	45,627,107.73
Furniture and Fixtures	311,875.64
Banking House	2,385,000.00
Other Real Estate	1,262,996.47
	$133,104,117.03

LIABILITIES

Capital Stock		$ 8,000,000.00
Surplus Fund		2,600,000.00
Undivided Profits, Net		3,351,934.27
Reserved for Taxes, Etc.		356,277.62
Reserved for Dividends		320,000.00
DEPOSITS		
Individual	$74,659,442.67	
Banks and Bankers	35,897,327.16	
U. S. Government	7,919,135.31	
		118,475,905.14
		$133,104,117.03

Includes over $17,000,000.00 in Loans to the Oil Industry

FIRST NATIONAL BANK

IN DALLAS MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Badger basin	150
Black Mountain	140
Cody dome	90
Cole Creek	110
Dallas Derby	350
Dewey dome	130
Dutton Creek	50
Elk basin	630
Frannie	130
Garland	3,400
Grass Creek	1,980
Hidden dome	100
Hudson	250
Iron Creek	30
LaBarge	860
Lance Creek	14,510
Lost Soldier	1,630
Medicine Bow	3,520
Mule Creek	90
Midway	30
Oregon basin	5,010
Osage	850
Quealy dome	760
Rock River	1,250
Spindletop	40
Poison Spider	280
Teapot	20
Warm Springs	150
Wertz	1,490
Total Wyoming	54,890

MONTANA

Border	60
Cat Creek	580
Cut Bank	8,080
Dry Creek	360
Kevin-Sunburst	3,590
Pondera	450
Total Montana	13,120

COLORADO

Florence	270
Fort Collins and Wellington	280
Wilson Creek	260
Iles dome	2,090
Moffat	330
Orchard	40
Rangely	70
Tow Creek	180
Price	550
Total Colorado	4,070

NEW MEXICO

Cooper	4,940
Eaves	900
Eunice	25,190
Hardy	2,760
Hobbs	14,100
Jal	1,020
Langlie	4,590
Lynch	570
Lynn	890
Mattix	3,360
Monument	26,000
North Lynch	40
Penrose	5,920
Rhoades	140
Skelly	1,970
South Eunice	3,140
Vacuum	4,990
Empire State	60
Artesia-Maljamar	7,970
Getty	300
Hogback	200
Rattlesnake	680
Table Mesa	30
Total New Mexico	109,760
Total Rocky Mountain region	181,840

Rocky Mountain Fields

(Continued from Page 227)

Niobrara County

The MacKinnie Oil & Drilling Co. No. 4 Thompson, SE SW NE Section 7-35n-65w, proved to be in some respects one of the best Leo sand wells so far completed in Lance Creek. It made 102 bbls. an hour through the open tubing at a total depth of 5,458 feet. It was still in sand when drilling stopped. Top of the pay was at 5,391 feet and the gas pressure was heavier than in the offset well, being 800 feet of gas to the barrel of oil. Another important factor was that it went through 68 feet of sand before drilling stopped with only two thin breaks of 3½ and 4½ inches, these being about 10 feet apart and consisting of shale rather than lime breaks found in other parts of the field. This makes the Leo at this location one of the largest single sand bodies so far encountered.

The well is of especial importance in that it and its offset, the Continental Oil Co. No. 1-B Dielman, which was completed two weeks ago for 100 bbls. an hour, mark an extension of the Leo sand pool half a mile out from the nearest production. No. 4 Thompson rotary table elevation is 4,463 feet. Principal tops were: Dakota, 3,515 feet; first Sundance, 4,038 feet; basal Sundance, 4,203 feet; red beds, 4,285 feet.

The next important completion will be the Adams Oil & Gas Co. and Felmont Corp. No. 1 Baker, half a mile east and a little south of the two new wells and the same distance southwest of the Minnelusa Oil Co. No. 1 H. & M., the nearest producer in that direction.

The Continental Oil Co. 63-mile pipe line from Lance Creek to Glenrock is being put into operation and its 250-mile line from Lance Creek to Denver is nearing completion.

Ohio Oil Co. No. 1 Jones, SE NE SE Sec. 30-35n-62w. Drlg. anhy. 1,484 ft.
J. E. Manning No. 1 Hewitt-Govt., NW SW SW Sec. 4-35n-65w. Loc.
Cow Gulch Oil Co. No. 1 MaGoon, NE NE Sec. 33-35n-64w. Drlg. 340 ft.
Ohio Oil Co. No. 6 Cash O.P.C.-2, NW NW NE Sec. 4-35n-65w. Drlg. anhy. 5,230 ft.; base r.b. 4,812 ft.
Fall River Royalty & Producers Co. No. 1 Govt., CSL SE SE Sec. 35-40n-61w. Drlg. 415 ft.
H. D. Moore et al No. 1 Bergrem, NW Sec. 23-35n-63w. S.D. 1,740 ft.; wtr. in top Converse sd. at 1,660 ft.
Adams O. & G. Co. No. 1 Baker, NW NE SW Sec. 8-35n-65w. Cmtd. surf. pipe at 318 ft.
Continental Oil Co. No. 2-B Dielman, NE NW NE Sec. 8-35n-65w. Drlg. top r.b. 4,323 ft.; top basal Sundance 4,228 ft.

Park County

The Stanolind Oil & Gas Co. No. 26 Elk-2, 140 feet east of C NE Section 24-58n-100w, Elk Basin field, was recompleted at 2,496 feet in the Dakota for 20,000,000 feet of gas per day. It was an old well deepened from 2,440 feet. The 8¼-inch was cemented at 2,357 feet and a 6⅝-inch liner was cemented at 2,313-2,493 feet and perforated.

Blue Ridge Oil Co. No. 1 Mau, NE NE SW Sec. 25-58n-98w. Loc.
Stanolind O. & G. Co. No. 18 Elk-5, NW NE NW Sec. 30-58n-99w. Bldg. rig.
Resolute Oil Co. No. 2 State, C SW SW Sec. 16-57n-101w. Cg. Frontier 8,763 ft.

Platte County

Bill Griffin et al No. 1, NE SE NE Sec. 18-30n-67w. S.D. 550 ft.

Sublette County

Texas Co.-Frontier Pet. Co. No. 1 Unit, SE SE SW Sec. 1-28n-114w. S.D. 6,155 ft. for repairs.
Yellowstone Oil Co. No. 1, 200 ft. N of S line of the H. L. Budd ranch, SE SE Sec. 31-13n-112w. S.D. 10 ft.
Progressive Oil Co. No. 1 Haddenham, C NE SE Sec. 21-28n-113w. Drlg. 832 ft.

Sweetwater County

Sinclair-Wyo. Oil Co. No. 80, NE NE NE Sec. 11-26n-90w. T.D. 1,943 ft. in sat. sd.; top Sundance 1,923 ft.; R.U.C.T.

Uinta County

Stove Creek Oil Co. No. 1 Govt., NE SW NE Sec. 26-14n-119w. Drlg. 1,567 ft.
Stove Creek Oil Co. No. 2 Govt., C SW NW Sec. 26-14n-119w. S.D. 300 ft.

Washakie County

Paul Boether No. 1 Govt., SW NW Sec. 4-47n-90w. S.D. 1,567 ft.
Frison Oil Co. No. 2 Govt., SE SW NE Sec. 24-47n-90w. Drlg. 145 ft.

Weston County

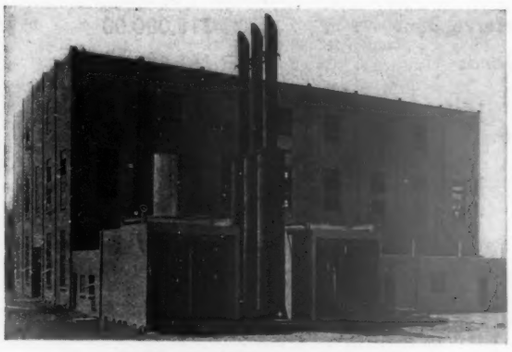
Lem Johnston has made a location for a test to the Muddy sand at around 2,000 feet in the Mush Creek district, southeast of the Osage field.

Lem Johnston No. 1, C SE SW Sec. 31-44n-62w. Loc.; (first report).
Selby & Langford No. 1, CNL NW SE Sec. 6-46n-63w. Spdg.
Geo. Keisling No. 1, SE SE NW Sec. 26-46n-64w. Cmtd. 8¼-in. through Greenhorn.
Whedon et al No. 1, Sec. 21-46n-64w. Spd. Sept. 28.
F. R. Dilger, Tr., No. 16, SW SW NE Sec. 30-46n-63w. T.D. 1,402 ft.; W.O.C.T.
West Osage Oil Co. No. 3, SW SE NE Sec. 15-46n-64w. Hd. tight sd. 2,140-54 ft.; will shoot.
John Borophy No. 1 George, SW SE NW Sec. 26-48n-64w. Drlg. 2,220 ft.

MONTANA

Crude oil production in Montana in September, as

Stop, Look, and Listen!



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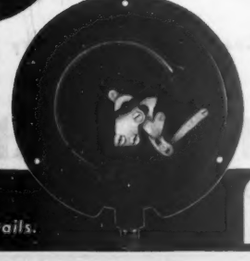

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Only Marsh Gauges have the "Recalibrator"—the first means of zero adjustment that actually corrects the gauge at all points on the dial.

Ask for details.

JAS. P. MARSH CORPORATION
2065 Southport Avenue, Chicago, Ill.

MARSH GAUGES

reported by the state Oil Conservation Board, was 401,407 bbls., a decrease of 4,729 bbls. as compared with August. Storage at the end of the month was 1,540,031 bbls., a decrease of 72,015 bbls. Of total consumption, 382,856 bbls. were refined in Montana, 49,088 bbls. were exported to Canada, and 35,436 bbls. shipped to other states, the remainder representing crude used for fuel and losses.

Big Horn County

Buzetti & Corkins No. 1, NE NW Sec. 23-1s-32e. M.I.M.

Blaine County

G. R. Teeters No. 1 Stam, CSL SW SE Sec. 10-31n-18e. (formerly R. E. O'Keefe). S.D. 860 ft. for csg.; top Eagle 630 ft.

Carbon County

R. C. Tarrant No. 2, SE NW Sec. 4-6s-18e. T.D. 2,410 ft.; fsg.
Henderson Prod. Co. No. 1-H-11 Elk 11, SE SE NW Sec. 35-9s-23e. S.D. 1,810 ft.
Sha-Wha Pet. Co. No. 1 Govt., SW NW NE Sec. 35-9s-23e. S.D. 3,124 ft.
Miracle Oil Co. No. 2 Govt., CWL NE SE Sec. 4-6s-23e. T.D. 2,337 ft. (C.D.); C.O. to res.; will U.R. to bttm. and set csg.

Cascade County

The E. B. M. Oil Co. has taken over the old Charles Merz well in the Coal Ridge district, No. 1 Betts, which has been standing for some time at 1,250 feet and is preparing to resume.

E. B. M. Oil Co. No. 1 Betts, CSL NW SE Sec. 34-18n-4e. T.D. 1,250 ft.; prep. to res.

Choteau County

Security Pet. Corp. No. 1 Johnson, C NE Sec. 23-26n-3e. S.D. 1,991 ft.; S.D. for 6⅝-in.; Sunburst 1,935-53 ft.

Dawson County

Frank C. Hughes No. 1 fee, NW NE SE Sec. 5-14n-55w. Drlg. 1,065 ft.

Daniels County

White Tail O. & G. Co. No. 2 Wiley, NW NW NW Sec. 10-36n-50e. Drlg. 1,928 ft.

Fallon County

Montana-Dakota Utilities Co. No. 45, Unit 7, SE NW SW Sec. 25-6n-60e. Drlg. 320 ft.

Fergus County

Baughman & Singley No. 1 Skaggs, C NW SW Sec. 7-15n-20e. S.D. 1,080 ft. (C.D.); in lower Quadrant.
Emmons et al No. 5 Stocker, SW NW SW Sec. 24-22n-18e. Drlg. 920 ft.; O.W.D.D. from 650 ft.

Judith Basin County

Fletcher E. Hunt No. 3, NW SE NE Section 30-14n-15e, Hobson district, which was dry in the top of the Madison at 1,746 feet, was deepened to test breaks in the lime and at 1,870 feet ran into 8,000 bbls. of water per day. Same operator is drilling some shallow wells around the test to pick up a sand at 311 feet which showed for small production.

Fletcher E. Hunt No. 1 Hoven, SE NE NW Sec. 30-14n-15e. Spdg.

Glacier County

The Santa Rita Oil & Gas Co. is moving in materials for another test in the North Cut Bank area close to the Canadian line in its No. 1 Lungren, SE SE SW Section 23-37n-5w. Location is three-fourths of a mile southeast of the Yukon Oil Co. No. 1 Jacobson, which was completed at 2,633 feet after plugging back for 60 bbls. of oil per day and some water. It also is 2 miles west of A. B. Cobb No. 1 State, C NE NE Section 30-37-4w, which made 40,000,000 feet of gas initially early in 1938 from the Moulton sand, but did not go to the Sunburst.

Santa Rita O. & G. Co. No. 1 Lungren, SE SE SW Sec. 23-37n-5w. M.I.M.; (first report).
Texas Co. No. 3 Curran, NE NE NW Sec. 8-32n-5w. Drlg. 1,081 ft.; Colo. 580 ft.; 10¾-in. 619 ft.
Consolidated Gas Co. No. 1 Tribal, NW NE NW Sec. 18-32n-5w. T.D. 1,920 ft.; fsg.
Glacier Prod. Co. No. 3 Van Ormer, CEL NW Sec. 17-33n-5w. Drlg. 2,435 ft.
Glacier Prod. Co. No. 1 Parker Unit, C N½ Sec. 28-34n-5w. Drlg. 2,500 ft.
K. D. Pardee No. 2 Tribal-179, CEL NE SE Sec. 12-32n-6w. Drlg. 2,700 ft.
C. P. Castle No. 4 State, CNL SW SW Sec. 36-35n-6w. Cmtd. 7-in. csg. 2,751 ft.; W.O.C.
Santa Rita O. & G. Co. No. 2 Lander, C S½ SE Sec. 16-35n-6w. Loc.

Park County

Ben Ryan et al No. 1 Burgess, SE SW NW Sec. 28-2s-11e. Drlg. 1,550 ft.

Petroleum County

H. Clark Rowland No. 1 Brundidge-Mink, SE NW Sec. 35-14n-25e. Skdg. rig from No. 1 Kalispel.
Watson Oil Co. No. 1 Austed, SW NW SE Sec. 22-13n-28e. Drlg. 565 ft.
O. B. Canfield No. 2 Govt., SE NE NE Sec. 21-17-24e. Drlg. 779 ft.

Phillips County

Treasure State Pool O. & G. Co. No. 4 Govt., C SE SW Sec. 2-24n-23e. S.D. 1,100 ft.; wtr. in top Madison.

Richland County

W. M. Fulton No. 1 Richardson, SW SW SE Sec. 29-26n-52e. Drlg. 540 ft.; small S.W. at 435 ft.

Teton County

Zodiac Oil Co.-Gulf States Oil Co. No. 1 Kellogg, NE NW NE Sec. 33-28n-5w. Drlg. 150 ft.
Gulf States Oil-Zodiac Oil Co. No. 1 Coffee-Wallenstein, SW SW SW Sec. 5-27n-5w. T.D. 2,525 ft.; redrlg. at 2,525 ft.

Toole County

Kevin-Sunburst had one completion, a dry hole, in P. L. Eddy No. 1 Sohn, SE SW NE Section 23-35n-3w, which would not take the acid, and was dry and abandoned at 1,725 feet. It had the contact at 1,660 feet.

The Montana Gas Corp. has made a location on the Bow and Arrow structure in the C SE SW Section 19-37n-1e, a mile to the east of its No. 2 Clark, which was completed last year at 2,630 feet for 18,000,000 feet of gas per day.

Lewistown-Flathead Oil Co. No. 2 Bashor, SE NW SE Sec. 9-35n-1w. Drlg. 1,845 ft.
Platt-Bell No. 1 Govt., SW NW NE Sec. 9-34n-2w. S.D. 455 ft.
C. L. Smith, Agt., No. 1 Govt., SW SE NW Sec. 13-35n-2w. Drlg. 640 ft.
Big West Oil Co. No. 4 Engle, SW SW SW Sec. 1-35n-3w. T.D. 1,850 ft.; Sunburst 1,601-38 ft.; top br. L. 1,720 ft.; swbd. ½ B.O.P.H.
Aspen O. & R. Co. No. 1 Govt., C NE SE Sec. 25-36n-3w. T.D. 2,060 ft.; 700 ft. W.I.H.; contact 2,010 ft.; will D.D.
W. M. Cassidy No. 1 Phoenix, CNL NW NW Sec. 28-35n-4w. S.D. 2,285 ft.
Fulton-Commonwealth No. 2 Thompson, NW NE SW Sec. 28-35n-3w. Drlg. 1,540 ft.; Sunburst 1,420-38 ft.; S.G.
H. C. Morton No. 8 Morton, C SW NW Sec. 24-34-2w. S.D. 1,440 ft.; good S.O. after acd.
Chas. Grant et al No. 1 Anderson, SE NE NE Sec. 26-35n-4w. S.D. 2,109 ft.
Colonel Kevin Oil Co. No. 1 Govt., SW NE NE Sec. 27-35n-3w. T.D. 1,488 ft.; rng. 7-in.

Yellowstone County

Signal O. & G. Co. No. 1 Stallinberger, NE NE SW Sec. 18-3n-23e. T.D. 4,955 ft.; clr.
Riverton Oil Co. No. 1 Fox, CEL NW NE Sec. 14-2n-23e. Drlg. 1,858 ft.

UTAH

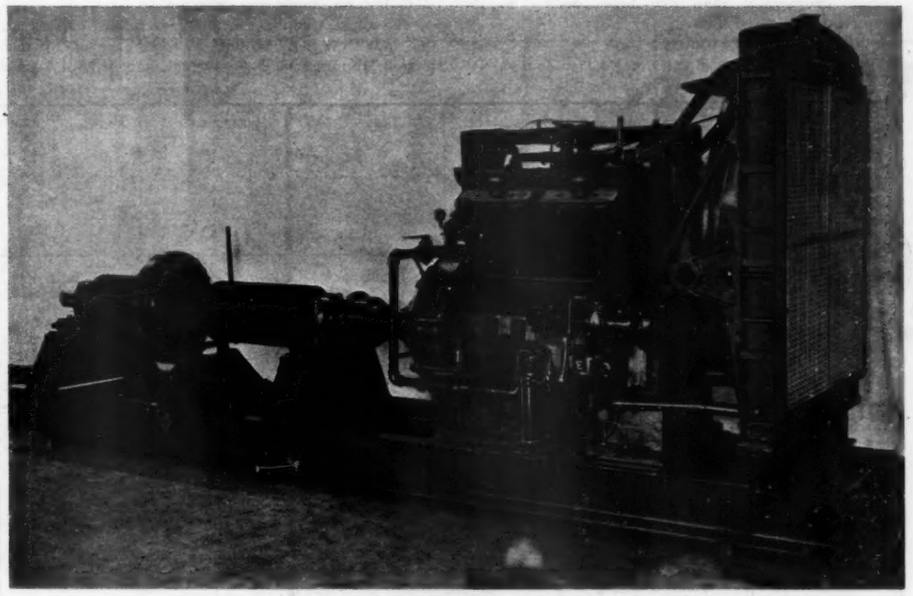
Grand County

Cane Creek Oil Co. No. 1 Govt., NW SW Sec. 31-26n-21e. Landed 8⅝-in. at 1,815 ft.
Crescent Eagle Oil Co. No. 1 Brendel, SW SE Sec. 4-22s-19e. Drlg. 4,110 ft.
Columbia Crude Corp. No. 1 Rath, NW SW SE Sec. 12-25s-20e. Drlg. 4,220 ft.

Summit County

Longwell Pet. Co. No. 1, SE SW SE Sec. 35-3n-5e. T.D. 2,876 ft.; sdtrkg.

★ This is the fourth of a series of advertisements featuring the use of Butane fuel in the Oil Industry.



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ENSIGN

Oklahoma Operations

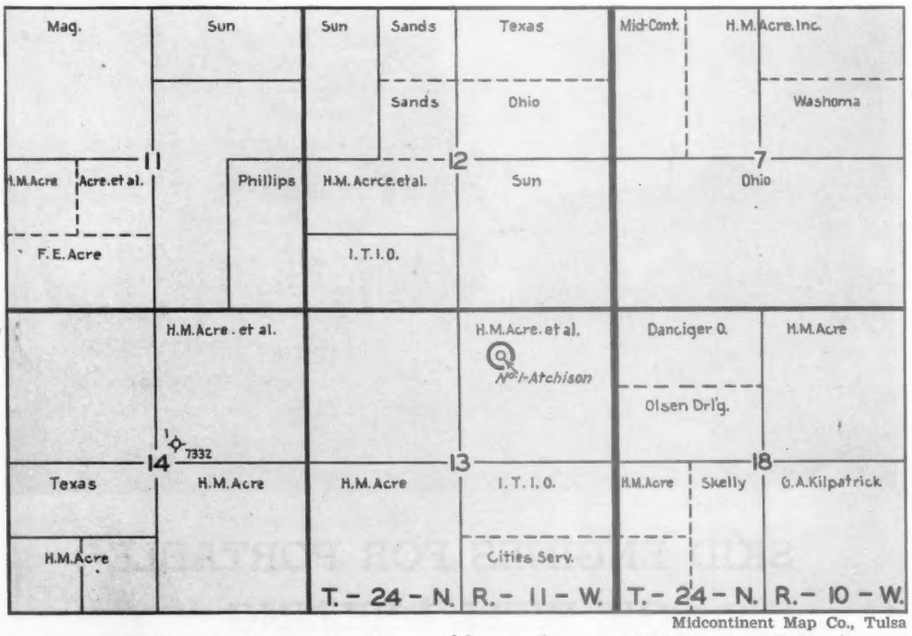
By
DAL DALRYMPLE

Outpost in Okfuskee County Finds Oil in Wilcox Horizon

Wilcox sand was proven productive in a new area in Okfuskee County, Oklahoma, at Lease Investment Co. No. 1 fee, SE SW SE Section 21-13-10, when 2,000 feet of oil rose in the hole from total depth of 3,613 feet in the pay. Sand was found at 3,600 feet. Operators were preparing to shoot and clean out before testing.

The outpost also had a showing of oil in Viola lime, topped at 3,540 feet, with elevation of 848 feet, as well as in Hunton lime. It was reported running higher structurally than dry holes drilled in the vicinity.

Earlier this year a Dutcher sand pool was opened at the nearby Broswood Oil Co. No. 1 Lehmer, NW SW NW Section 21-13-10. It flowed 40 bbls. of oil daily from Dutcher sand at 2,841-66 feet, total depth. Nearest Wilcox sand production is in the Okfuskee pool, opened by Mid-Continent Petroleum Corp. at No. 1 Irelan, SW NE SW Section 10-13-10. It pumped 107 bbls. of oil initially in 12 hours from Wilcox sand at 3,420-31 feet.



Midcontinent Map Co., Tulsa

H. M. Acre and associates are starting a wildcat in Section 13-24-11w, in Alfalfa County, and west of the new Garfield County pool near Hillsdale

In Lincoln County

Fate of one of the more interesting Oklahoma wildcats may be determined within the next week. It is the Summit Drilling Co. and others No. 1 Gordon, NE cor. Section 27-17-2e, in the extreme northwestern corner of Lincoln County and near boundaries of Payne and Logan counties. Operators were moving out rotary equipment preparatory to installing cable tools and drilling in. Wilcox sand was topped at 4,804 feet and penetrated to 4,835 feet, cores showing stains of oil.

Two wells were nearing completion in the Sac and Fox pool, Lincoln County. Coralena Oil Co. No. 1 Sac and Fox, NE NE SE Section 16-14-6, was bailing preparatory to drilling into Prue pay. Wilcox Oil & Gas Co. No. 3 Saylor, SW NW NW Section 14-14-6, found Prue sand at 2,683 feet and was waiting after setting 6⅝-inch casing at 2,855 feet. Same company was moving in tools at No. 4 Saylor, SW SW NW Section 27-17-2e.

Cleveland Wildcats

Gulf Oil Corp. No. 1 Taylor, SE SE SW Section 1-7-2w, 1 mile north of the Noble pool in Cleveland County, was coring below 7,666 feet, looking for Wilcox sand. Dry sand and dolomite was recovered in cores at 7,654-61 feet and 7,661-66 feet. It was reported checking about 10 feet lower than the Noble discovery well, but no water was showing.

Big Chief Drilling Co. and associates No. 1 Strateger, NW NW SW Section 25-9-2w, east of Norman, topped Hunton lime at 6,840 feet, had drill pipe stuck at 7,179 feet, cemented over fish, tried to drill by and had to recement whipstock.

Harper-Turner and others No. 1 Taylor, SE NE NW Section 23-8-2w, north of the town of Noble, had spudded.

Kay County Activity

Two outposts in Kay County were due for decisions within the next few days. Tide Water Associated Oil Co. No. 1 Hockman, NW NW NE Section 19-28-1e, deep test in the old Dilworth area, had oil showing in Wilcox sand topped at 3,288 feet, was drilled to Arbuckle lime at 3,421-48 feet, total depth, plugged back to 3,230 feet and set 5-inch casing at 3,290 feet. After completing a fishing job the crew was drilling out cement preparatory to testing sand at 3,288-3,327 feet.

Atlantic Refining Co. No. 1 Watson, SE SE NW Section 28-28-1w, about 1 mile south of the South Braman area, was coring ahead slowly below 3,640 feet in Wilcox sand. Shows of oil were reported.

Seeking Deep Pay

Continental Oil Co. No. 1 Proctor, C NW Section 28-10-20w, wildcat in Washita County and southeast of Elk City, was drilling below 9,345 feet, with formation tops not reported. Currently, it is the deepest drilling well in Oklahoma.

Carter Oil Co. and others No. 1 Smith, C SE SW Section 26-5-8w, proposed 10,000-foot test in the old Chickasha gas field, Grady County, was making hole below 5,040 feet in shale.

Pure Oil Co. No. 1 Noble, C NE SE Section 35-3s-1e, 5 miles north of Ardmore in Carter County, was drilling below 1,655 feet. It is a proposed 9,000-foot test.

Continental Oil Co. No. 1 Donahoe, NW NW SW Section 16-18-2w, south of Mulhall in Logan County, was drilling in dry dolomite below 5,982 feet and reported checking low.

H. M. Acre and associates were reported about ready to spud at No. 1 Atchison, C NW NE Section 13-24-11w, proposed deep test in southern Alfalfa County of the new Hillsdale area in Garfield County.

Jones Associated Oil Co. is reported to have started work at No. 1 Wolfe, SE SW NW Section 13-22-4w, a Wilcox sand test on the north side of the Garber pool. At one time 22 shallow wells were producing on this lease.

Estimated Daily Production

Estimated daily production for Oklahoma for the week ending November 12, and for the preceding week, was as follows:

	Barrels	
	Nov. 12	Nov. 5
Allen	6,150	5,975
Billings	5,150	5,025
Burbank	7,775	7,750
South Burbank	8,775	10,400
Balance Osage	15,250	15,000
Blackwell district	4,150	4,175
Bristow-Slick	6,925	6,975
Chandler	2,000	2,025
Crescent	3,775	4,050
Cromwell	3,175	3,150
Cushing-Shamrock	10,225	10,200
Duncan district	4,225	4,200
Edmond	4,900	4,925
Fish	3,050	5,125
Fitts	37,075	38,350
Jesse	2,725	3,050
Graham-Fox	4,375	4,350
Gray	825	800
Healdton	9,550	9,875
Hewitt	3,600	3,625
Keokuk	4,075	4,050
Konawa	1,325	1,375
Lucien	8,175	8,050
Moore	4,675	4,700
Oklahoma City	105,275	88,075
Olympic	4,350	4,225
Ramsey	2,425	2,375
Sasakwa	1,325	1,300
Sholem-Alechem	2,425	2,450
Seminole district:		
Bowlegs	9,175	9,225
Carr City	3,375	3,425
Dora	5,075	5,125
Earlsboro	5,225	5,175
South Earlsboro	450	475
East Earlsboro	4,575	4,600
Little River	7,350	7,325
East Little River	850	825
Maud	650	700
Mission	1,600	1,625
Seminole	8,225	8,200
East Seminole	1,600	1,625
Searight	2,875	2,850
Total Seminole	51,025	51,175
St. Louis-Pearson	24,400	24,300
Tatums	2,500	2,550
Tonkawa-Garber-Thomas	4,050	4,075
Wewoka	2,200	2,225
Yale-Jennings	3,800	3,775
Other pools	85,000	83,250
Total Oklahoma	450,700	436,975

Oklahoma City Area

Another producer was near completion east of the fault on the northeast edge of the Oklahoma City field at Clark & Co. No. 1 Dinwiddie, SE NW SE Section 23-12-3w. Bottomed at 6,738 feet in Simpson detrital zone, it was said to have filled two 1,000-bbl. tanks in less than two days and was expected to settle down

to about 250 bbls. daily. Operators were to run tubing and produce the well through choke in order to prevent dissipation of reservoir energy.

Jones Associated Oil Co. was due to test at No. 1 Harn, on the west side of the field. It found Wilcox sand at 6,477-87 feet, total depth, and oil rose 3,000 feet in the hole after cleaning out.

Davon Oil Co. and others No. 1 Glidden, SW SW SE Section 13-11-3w, in the older sector of the City field, was showing oil at 4,400 feet in Hoover sand and was to be shot.

Meridian District

Completion of another well in the Meridian pool, Logan County, appeared imminent at Helmerich & Payne and Deep Rock Oil Corp. No. 1 Humphreys, NE NE SW Section 27-16-1e, southwest offset to the discovery well. Top of Wilcox sand was found at 5,251 feet, total depth 5,271 feet, with saturation reported. Six and five-eighths inch casing was set at 5,210 feet. Cement plug was to be drilled as soon as cable tools could be moved in.

Helmerich & Payne and others No. 1 Strain, NW NW SE Section 27-16-1e, south offset to the discovery well, was drilling below 4,805 feet.

St. Louis Field

Alma Oil Co. No. 3 Curley, NW SW NW Section 33-7-5, St. Louis district, Pottawatomie County, pumped 225 bbls. of oil and an equal amount of water in 24 hours after deepening from 4,031 feet to 4,075 feet.

Atlantic Refining Co. No. 1 Goss, Section 6-6-4, was waiting after setting pipe at 4,516 feet in second Wilcox sand. It was said to have 2,400 feet of oil and 600 feet of water in the hole.

Morgan, Flynn & Cobb and Summit Drilling Co. No. 1 School Land, NE NE SW Section 16-8-5, in the Maud-Carr City sector of Pottawatomie County, was estimated good for 500 to 1,000 bbls. of oil after plugging back from 4,270 feet in Wilcox sand to 4,033 feet in Hunton lime and perforating casing. Gas was estimated at 10,000,000 feet. Separator was being installed.

Panhandle Gas Area

Republic Natural Gas Co. No. 1 Judd, SW SW Section 24-6n-15ecm, Texas County, Oklahoma Panhandle, was reported completed for 16,500,000 feet of gas daily. It was acidized at 2,684-2,855 feet.

Stripper Well Problem

A relief plan for stripper wells of eastern Osage and northern Tulsa counties was rejected at a meeting of operators and owners in Tulsa last Thursday. The proposal provided that oil from the stripper wells be run and stored at Barnsdall at a monthly cost of 1 cent a barrel, with the understanding that the oil would be bought by Barnsdall Refining Corp. when operations are resumed at its Barnsdall refinery, shut down since October 15. The operators directed the producers committee, headed by H. E. Geiger, Devonian Oil Co., to continue its quest for a new outlet for the wells that have been shut in since the Barnsdall company quit taking the oil. The operators also adopted a motion asking the Osage Indian Agency at Pawhuska to restrain the Barnsdall company from running oil from its own wells unless the allowable from offsets also was run. Another meeting of the stripper operators was set tentatively for November 21.

East Texas Fields

(Continued from Page 223)

Markham No. 1-B A. L. Still, 3,512-33 feet, 5 bbls. Overton Refining Co. No. 2 Florence, 3,547-60 feet, 180 bbls.

Rusk County—Joiner Area

Humble Oil & Refining Co. No. 25 W. A. Mulliken, 3,670-3,715 feet, 60 bbls.; No. 16 J. E. B. Sneed, 3,767-3,773 feet, 80 bbls. Shell Petroleum Corp. No. 23-A H. Brooks, 3,658-3,758 feet, 35 bbls. Stanolind Oil & Gas Co. No. 18 J. B. Milstead, 3,654-3,745 feet, 8 bbls. Zepher Oil No. 5 Fredrick, 3,540-3,650 feet, 10 bbls.

Upshur County—Longview Area

Atlantic Refining Co. No. 17 Walker, 3,621-64 feet, 72 bbls.; No. 20 Walker, 3,638-3,793 feet, 68 bbls. Humble Oil & Refining Co. No. 13 A. O. Phillips,

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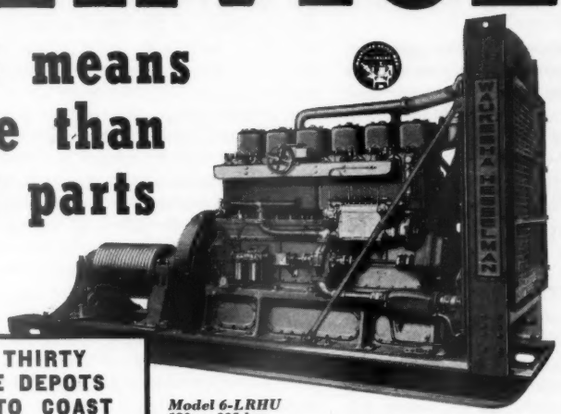

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Greggton, Texas
Hobbs, New Mexico
Houston, Texas
Kettleman Hills, Calif.
Long Beach, Calif.
Longview, Texas
McPherson, Kans.
Mt. Pleasant, Mich.
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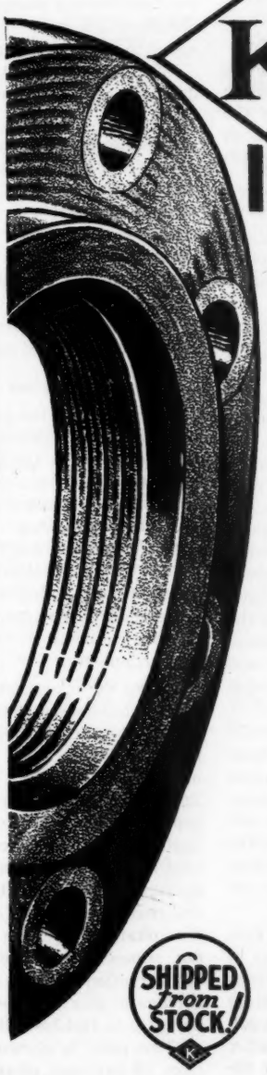

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3,600-99 feet, 30 bbls. Pewitt No. 7 T. J. Kirk, 3,607-08 feet, 40 bbls. Stanolind Oil & Gas-Falcon No. 7 J. B. Clowd, 3,683-84 feet, 61 bbls.

Rusk County—Kilgore Area

Devonian Oil No. 44 R. A. Motly, 3,660-77 feet, 71 bbls.

EAST CENTRAL TEXAS COMPLETIONS

(24-hour tests)

Anderson County

Tide Water-Seaboard No. 8 W. H. C. Goode, 3,950-93 feet, 85,000,000 feet of gas.

Cherokee County

J. R. Bunn No. 2 C. Bounds, 3,970-4,010 feet, 2 bbls.

Leon County

T. J. Tucker No. 1 Sam Bain, 5,503-45 feet, 171 bbls.

West Texas Fields

(Continued from Page 224)

3,012-54 feet, 365 bbls.; No. 9 Thompson, 3,136-64 feet, 151 bbls. Cy Rieger No. 3 Hodges B, 2,995-3,030 feet, 542 bbls.

Moore County

Phillips Petroleum Co. No. 1 Mills, 2,905-3,245 feet, 39,533,000 feet of gas.

PROPANE

(Continued from Page 210)

able as such, these operations are highly advantageous irrespective of the crude and product price structure. Even when the heavy products must be discarded as fuel, it is always possible to vary the amount of precipitation to maintain conditions which are optimum for any given economic situation.

Reducing Manufacturing Costs

In any consideration of manufacturing costs, it is desirable to confine the analysis within close limits to simplify comparisons in so far as possible without sacrificing accuracy. For this reason, it is advisable to compare the relative costs of producing lubricating oils by the older conventional methods with those by the more modern refining processes, after the crude oil has been subjected to its primary distillation and segregated into its component parts.

It should be pointed out that, in the case of almost all refiners of Pennsylvania crude, the only manufacturing costs which are involved in the production of lubricating oils are for two fundamental purposes; namely, dewaxing and decolorizing. Several different operations may be involved in the production of neutral from wax distillate and of bright stock from cylinder stock, but in the final analysis only two purposes have been accomplished—the raw stocks have been dewaxed and decolorized. Hence, the price differentials which exist between waxy neutral and dewaxed neutral, in one case, and between cylinder stock and bright stock, in the other case, are dependent only upon the costs of dewaxing and decolorizing the waxy neutral and cylinder stock, respectively. Fundamental consideration of the propane processes and practical operating experience with them at the Kendall Refining Co. have shown conclusively that significant reductions in manufacturing costs can be made by their use.

Propane can be applied by the Pennsylvania refiner to the reduction of manufacturing costs in three different ways. It can be used as a solvent and refrigerant for dewaxing distillate and residual stocks without deresining; it can be used as a solvent for deresining residual stocks before or after dewaxing by any process; or it can be used for carrying out both dewaxing and deresining operations in a single plant.

In considering the manufacturing cost for dewaxing alone, it is important to evaluate not only the major items of operating cost, utilities and labor, but also the increased yields which are obtained in the dewaxing operation and any changes which might affect subsequent decolorizing costs. The refiner installing a new dewaxing plant today should expect to make savings by reducing the cost of utilities and labor, by securing higher yields of dewaxed oil, and, if he selects propane dewaxing, by reducing the cost of subsequent decolorizing because propane has the ability to precipitate color bodies with the wax.

Operating data obtained at the Kendall refinery indicate that if propane dewaxing alone had been installed, the economies effected would have been sufficient to pay for the plant in approximately two years. Since increased yields and reduced operating costs alone would have permitted paying for the plant in about 2.6 years the difference shows the value of the decolorizing which accompanies propane dewaxing.

Uniform plant operation and consistently high yields are essential factors in manufacturing cost in any plant which is installed to serve a definite economic function. Daily throughputs obtained in the propane dewaxing and deresining plant of the Kendall Refining Co. during the first six months of 1938 are contained in Figure 3. These data show that, even though the plant charged a variety of different stocks, frequently for short periods of time, the throughput was essentially constant, the average capacity during the first six months of 1938 being 1,053 bbls. per stream day. During the past two months the plant has been operated on both distillates and residual stocks at throughputs which are 15 to 20 per cent higher than this average.

The dewaxing and deresining yields obtained during the first six months of 1938 are shown in Table 2.

The flexibility of the propane dewaxing process, as shown by the capacity and yield data on various stocks, is an important item in manufacturing cost. Most of the yield and operating cost savings which may be credited to the new dewaxing processes for Pennsylvania oils result from improved operation on residual stocks. However, the consolidation of distillate and residual dewaxing plants in one unit results in quite definite savings in labor and maintenance and in fixed costs.

Reduces Pay-Off Time

The ability of the propane dewaxing process to precipitate a portion of the coloring matter from the oil and reduce the decolorizing cost by about 30 per cent results in a reduction of the pay-off time for a 1,000-bbl. plant from about 2.6 to 2 years. Addition of a deresining step still further reduced this pay-off time by greatly reducing clay requirement with only a small decrease in finished oil production of a deresining step still further reduces this increases the percolation yield by approximately 100 per cent and decreases the decolorizing cost proportionately.

Using the operations of the present plant as a basis, it has been estimated that a propane deresining plant (without dewaxing) for handling 1,000 bbls. of cylinder stock per day would show a pay-off period of about 1.8 years as a result of savings in the cost of decolorizing by removing about 4 per cent of resins. These resins cannot be debited against the process because experience has shown that a large part of the material removed by deresining would normally have been taken out by the decolorizing step. A deresining plant could precipitate much more of the cylinder stock without appreciable increase in cost, but when the resin fraction amounts to more than 6 per cent the savings in clay alone will not always pay for the decrease in finished oil.

This point is shown by the operations to produce 13 per cent of resins, where the clay consumption was only 20 per cent of the requirement when using conventional dewaxing. Where the removal of 4 per cent resins reduced the clay consumption by 50 per cent, the removal of the additional 9 per cent reduced it to only 30 per cent with a net saving of only 35 cents per barrel and a net decrease of nearly 4 gallons of finished bright stock per barrel of charge. Obviously, if finished bright stock has a different value of 15 cents per gallon, this operation must depend on production of materials other than fuel from the resins, or on the increase in neutral equivalent. On the other hand, if the differential value is only 6 cents per gallon, the operation is economically justified even if the resins are discarded as fuel, and the increased neutral equivalent is an added advantage.

Although either a propane dewaxing plant or a propane deresining plant will show a satisfactory pay-off period when installed separately, the combination of both processes in a single unit is even more attractive. The operations over the past 18 months show that the economies effected by installation of a combined plant to charge 1,000 bbls. per day result in a pay-off period of about 20 months. A comparison of the operating costs for a plant to dewax 1,000 bbls. per day of cylinder stock, and deresin the dewaxed oil, with corresponding costs for the separate plants, is shown in Table 3. The difference in the costs is about 13 cents per barrel of cylinder stock or about $45,000 per year in favor of the combined plant, and the installation cost for the combined plant would be about $100,000 lower than for the separate plants.

Obviously, all refiners of Pennsylvania oils will not have the same costs for utilities and labor, and for this reason the accompanying chart, Figure 6, has been prepared so that each refiner can estimate, for his own conditions, the approximate operating cost when employing propane to dewax and deresin Pennsylvania cylinder stock. The example chosen on this chart is based on one particular set of unit costs, but a refiner may substitute his own costs to determine an approximate total operating cost. Actual design for any given situation might change the relative proportion of various items in order to arrive at a minimum cost, so that such figures cannot be considered as final.

The economic advantages of propane processes in other refineries would not necessarily be the same as for the conditions at the Kendall Refining Co. since the relative importance of dewaxing and decolorizing costs may vary to some extent. It has been shown, however, that propane dewaxing and propane deresining will bring about a reduction in the cost of both of these operations, and it can be expected that savings will be made in other refineries comparable with those which have been made by the Kendall Refining Co.

Summary

The facts presented in this paper may be summarized as follows:

1. The status of the Pennsylvania refiner as a manufacturer and marketer of lubricating oils has been appreciably changed during the past few years by events which include: (*a*) Competition of improved oils produced from lower cost crudes; (*b*) reduction in the average viscosity required for automotive oils with a resultant greater surplus of bright stock, and (*c*) demand for lubricants of still higher quality brought about by the use of more severe engine conditions.

2. To combat these changed conditions, it appears that the Pennsylvania refiner should make changes in his refining methods which will improve the quality of lubricants produced, increase the quantity of neutral equivalent obtained from the crude, and decrease manufacturing costs.

3. Commercial operating results have been presented which show that the use of propane processing methods will reduce manufacturing costs, increase the amount of blended motor oils which can be made and correspondingly decrease the surplus bright stock, while at the same time giving an increase in the overall yield of lubricants and some improvement in the quality of the bright stock and serving as a means of preparing residual stocks for most efficient treatment with selective single solvents.

Michigan Field Report

By
O. C. PRESSPRICH

New Pools Oversupply Pipe Lines; Proration Is Needed

SAGINAW, Mich., Nov. 14.—Flush Clare County oil production dominated Michigan fields last week, with seven producers jumping daily potentials more than 18,000 bbls., held down by pipe line proration to 7,000 bbls. actual daily initial production from the entire field. Three other Michigan fields reported new producers adding about 3,000 bbls. daily, the Van Buren-Bloomingdale pool accounting for 2,300 bbls. daily from five new wells, with the Allegan and Edenville pools adding one producer each.

All fields except the Freeman-Redding in Clare showed the effects of market conditions on new production. The Freeman-Redding area continues to develop its highly prolific oil wells—some of the best in Michigan—in the face of a voluntary cooperative move of Clare operators to establish an equitable proration on the basis of market conditions. A preliminary meeting of Clare producers here November 7 decided on voluntary proration as a step in the right direction. All operators were represented and they named a committee to set up a cooperative plan. Edward F. Clagett of Pure Oil Co. was named chairman, with the following other committee members: Charles W. Teater, Saginaw producer; W. P. Clarke of Gulf Refining Co.; Kurt DeCousser of Socony-Vacuum; Crawford Daily of Daily Crude Oil Co.; Don E. Holbrook of the Higelmire Trust interests, and C. L. Maguire of Roosevelt Oil Co.

The Van Buren County Bloomingdale field's five new producers fell far short of the high rating of the 13 new wells added in this field the previous week. Drilling lists showed 55 locations staked or actually drilling. Only one producer was brought in in Allegan, and Midland County's Edenville pool, inactive for several weeks, showed one new producer. Altogether there were 14 new producers last week, and seven dry holes.

Allegan County

Dorr Township (4n-12w)—Black Rock Oil Co. No. 2 Harnish, SW NE SW Section 30, was the lone Dorr producer of the week, acidized to 200 bbls. daily.

Monterey Township (3n-13w)—Only completion of the week, abandoned as a dry hole, was P. K. DeGuenther No. 1 Church, SE SE NW Section 2, an attempt to extend the original field to the northwest.

Salem Township (4n-13w)—J. B. Northcott No. 4 Schipper, NW SE NW Section 21, failed to log oil, and will be abandoned.

Saugatuck Township (3n-16w)—A wildcat failure was completed at Haze & McGill No. 1 Benson, SW NW SE Section 34.

Clare County

Freeman Township (18n-6w)—Any doubt that might have existed regarding the production of the Clare-Freeman oil pool was dispelled last week when six new producers hoisted daily potentials more than 18,000 bbls. One of the big producers was estimated variously from 5,000 to 8,000 bbls. daily. Due to the high hourly flow, which exceeded 300 bbls., it was practically impossible to obtain an accurate gauge. With only 22 producing wells in the Freeman-Redding area on October 31—since increased—the field has jumped into third place in state production, trailing the six Allegan-Van Buren combined fields by only a slight margin. These fields had 245 wells on October 31.

Largest addition of the week in the Freeman field was Socony-Vacuum No. 5 Van Horn, NW NE NW Section 3, in the center of the producing area. The test ran 300 bbls. or better for the first few hours, showing steady increase, and operators estimated it would gauge at least 5,000, possibly 8,000 bbls., natural flow. It was pinched in after the first few hours, but its prolific production in the natural state was taken to indicate it is the largest well in the field to date. The same company's No. 6 Van Horn, NW NW NW Section 3, came in a day later and gauged an estimated 2,000 bbls. naturally. Higelmire Trust No. 3 Van Horn, NW SW NW Section 3, logged 3,500 bbls. natural production, and Gulf Refining Co. No. 4 Van Horn, SE SE NW Section 3, was acidized to an estimated 3,500 bbls. daily. Pure Oil Co. No. 2 Pure-Shell-Van Horn, NW NE SW Section 3, was rated 500 bbls. after acid, and the No. 1 Pure-Shell-Van Horn, NE NW SW Section 3, brought in a day later, exceeded 1,000 bbls. daily, naturally.

Redding Township (19n-6w)—One completion in the Redding area, directly north of Freeman, spread the productive area westward the past week. McClanahan Oil Co. No. 1 Slater, SE NW SW Section 33, gauged 500 bbls. daily after acid.

Kent County

Walker Township (7n-1w)—Kent County's first producer, which operators say may indicate a new state oil pool, was brought in last week at McCallum & Herr No. 1 Story wildcat, SE SE SW Section 32, estimated between 50 and 60 bbls. daily settled production. The wildcat is the first test to sample pay in Kent, although no extensive exploration has been undertaken. The well logged the Traverse top at 1,835 feet, the pay zone at 1,872 feet, bottomed at 1,892 feet, with oil filling the hole. After acid treatment the well settled to about 60 bbls. daily. Operators indicated that cautious wildcatting would result from this favorable showing.

Midland County

Edenville Township (16n-1w)—For the first time in several weeks the Edenville pool showed activity, with one completion recorded last week. It was Sun Oil Co. No. G-1 State-Edenville, NE SE SW Section 27, rated as a 500-bbl. daily producer after acid. Only three other wells are drilling in Edenville, two being Sun Oil projects, one owned by Pure Oil Co.

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Wise-Isabella	1	44
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Freeman-Temple	22	7,498
Grant-Clare	2	22
Beaverton	23	217
Edenville	29	2,153
Bentley-Gladwin	32	681
Buckeye-Wicklund-Oard	408	13,508
Ogemaw	230	3,091
Secord-Gladwin	2	22
Adams-Arenac	11	151
Clayton-Arenac	52	2,891
Tuscola	1	22
Saginaw area	57	77
Birch Run	25	47
Dundee-Monroe	3	20
Montcalm County	60	617
Allegan area—six pools	245	7,808
Muskegon	85	105
Totals	2,055	51.173

Van Buren County

Bloomingdale Township (1s-14w)—Five producers, which added an estimated 2,300 bbls. daily potential, and two dry holes, summarized activity in Van Buren after the previous week's addition of 13 producers exceeding 10,000 bbls. daily. Midway sections of the Bloomingdale pool showed all the activity, with shallow production holding up among the new additions. The Bloomingdale pool shows the largest list of active drilling wells of any in Michigan, with 55 locations reported in various stages of completion. Some of these, however, have been shut down, owing to overproduction and weakened market conditions. Largest producer of the week in Bloomingdale was E. S. Shoemakers No. 1 Rodgers, NE SE NE Section 17, rated at 1,000 bbls. daily after acid. Bloomingdale Development Co. No. 1 Broughton, NW SE NE Section 17, was acidized to 700 bbls. daily. Prather & Hunt No. 1 Rumery, NW SE NE Section 17, gauged 300 bbls. daily after acid, and Bridger Basin Oil Co. No. 1 Brown, NE SE NE Section 17, was rated 250 bbls. daily naturally. M., R. & T. Oil Co. No. 1 Rowlinson, NW SW NW Section 16, rated as a small producer, gauged 50 bbls. after acid.

Hamilton Township (3s-15w)—A wildcat attempt to prove a producing vein southwest of Bloomingdale failed last week at Gulf Refining Co. No. 1 Wasylenski, SE SE SW Section 23, abandoned as dry.

December Lease Sale

Oil and gas leases on 11,236 acres of state-owned lands in Clare, Midland, Ogemaw, Roscommon and Gladwin counties will be auctioned December 2 by the lands division of the Michigan conservation department. Most of the acreage lies either in state forests or in state game refuges, 580 acres in areas already proved for oil production, the remainder wildcat.

Listed as wildcat territory are 3,247 acres in the Clare County end of Houghton Lake state forest, 1,809 acres in the Roscommon County end of the Houghton Lake forest, 3,750 acres in Midland County, of which 2,540 acres are in the Sanford game refuge, 520 acres in the Ogemaw game refuge in Ogemaw County, and 1,791 acres of cut-over pine forest lands in Roscommon County.

Good bonuses are expected by the conservation department on a 40-acre tract in Section 33-19n-6w, Midland County, and an 80-acre tract in Section 34-16n-1w, Clare County. In Gladwin County the proved offering is 640 acres on which leases have been surrendered because offsets were drilled in advance of the lessees' operations.

Small Pumping Well First Producer in Scotland

Decision has been reached to complete Anglo-American Oil Co. No. 1 Midlothian, near Dalkeith, Scotland, for a small pumping well, thus establishing it as the first commercial producer obtained in the broad scale exploration program in Great Britain.

At 2,200 feet No. 1 Midlothian tested for approximately 4,000,000 feet of gas with a closed-in pressure of 720 pounds. The hole was plugged back by stages to 2,100 feet, and finally to 2,050 feet. Casing was gun perforated from 1,730 to 1,760 feet to test the original showing of oil obtained last June in sand at 1,733 to 1,760 feet. While being swabbed through tubing for two hours each day the well is now yielding about 25 bbls. of fluid, half water and the remainder 32-degree A.P.I. oil. The test was drilled to total depth of 3,857 feet before plugging back and testing operations were ordered. Encouraged by the showing obtained in the first test, Anglo-American has moved its drilling rig to a new location about a half mile north and a little west for No. 2 Midlothian.

D'Arcy Exploration Co., subsidiary of Anglo Iranian, is preparing to start its No. 2 Cousland about 2 miles north of Anglo-American's second location.

3,600-99 feet, 30 bbls. Pewitt No. 7 T. J. Kirk, 3,607-08 feet, 40 bbls. Stanolind Oil & Gas-Falcon No. 7 J. B. Clowd, 3,683-84 feet, 61 bbls.

Rusk County—Kilgore Area

Devonian Oil No. 44 R. A. Motly, 3,660-77 feet, 71 bbls.

EAST CENTRAL TEXAS COMPLETIONS

(24-hour tests)

Anderson County

Tide Water-Seaboard No. 8 W. H. C. Goode, 3,950-93 feet, 85,000,000 feet of gas.

Cherokee County

J. R. Bunn No. 2 C. Bounds, 3,970-4,010 feet, 2 bbls.

Leon County

T. J. Tucker No. 1 Sam Bain, 5,503-45 feet, 171 bbls.

West Texas Fields

(Continued from Page 224)

3,012-54 feet, 365 bbls.; No. 9 Thompson, 3,136-64 feet, 151 bbls. Cy Rieger No. 3 Hodges B, 2,995-3,030 feet, 542 bbls.

Moore County

Phillips Petroleum Co. No. 1 Mills, 2,905-3,245 feet, 39,533,000 feet of gas.

PROPANE

(Continued from Page 210)

able as such, these operations are highly advantageous irrespective of the crude and product price structure. Even when the heavy products must be discarded as fuel, it is always possible to vary the amount of precipitation to maintain conditions which are optimum for any given economic situation.

Reducing Manufacturing Costs

In any consideration of manufacturing costs, it is desirable to confine the analysis within close limits to simplify comparisons in so far as possible without sacrificing accuracy. For this reason, it is advisable to compare the relative costs of producing lubricating oils by the older conventional methods with those by the more modern refining processes, after the crude oil has been subjected to its primary distillation and segregated into its component parts.

It should be pointed out that, in the case of almost all refiners of Pennsylvania crude, the only manufacturing costs which are involved in the production of lubricating oils are for two fundamental purposes; namely, dewaxing and decolorizing. Several different operations may be involved in the production of neutral from wax distillate and of bright stock from cylinder stock, but in the final analysis only two purposes have been accomplished—the raw stocks have been dewaxed and decolorized. Hence, the price differentials which exist between waxy neutral and dewaxed neutral, in one case, and between cylinder stock and bright stock, in the other case, are dependent only upon the costs of dewaxing and decolorizing the waxy neutral and cylinder stock, respectively. Fundamental consideration of the propane processes and practical operating experience with them at the Kendall Refining Co. have shown conclusively that significant reductions in manufacturing costs can be made by their use.

Propane can be applied by the Pennsylvania refiner to the reduction of manufacturing costs in three different ways. It can be used as a solvent and refrigerant for dewaxing distillate and residual stocks without deresining; it can be used as a solvent for deresining residual stocks before or after dewaxing by any process; or it can be used for carrying out both dewaxing and deresining operations in a single plant.

In considering the manufacturing cost for dewaxing alone, it is important to evaluate not only the major items of operating cost, utilities and labor, but also the increased yields which are obtained in the dewaxing operation and any changes which might affect subsequent decolorizing costs. The refiner installing a new dewaxing plant today should expect to make savings by reducing the cost of utilities and labor, by securing higher yields of dewaxed oil, and, if he selects propane dewaxing, by reducing the cost of subsequent decolorizing because propane has the ability to precipitate color bodies with the wax.

Operating data obtained at the Kendall refinery indicate that if propane dewaxing alone had been installed, the economies effected would have been sufficient to pay for the plant in approximately two years. Since increased yields and reduced operating costs alone would have permitted paying for the plant in about 2.6 years the difference shows the value of the decolorizing which accompanies propane dewaxing.

Uniform plant operation and consistently high yields are essential factors in manufacturing cost in any plant which is installed to serve a definite economic function. Daily throughputs obtained in the propane dewaxing and deresining plant of the Kendall Refining Co. during the first six months of 1938 are contained in Figure 3. These data show that, even though the plant charged a variety of different stocks, frequently for short periods of time, the throughput was essentially constant, the average capacity during the first six months of 1938 being 1,053 bbls. per stream day. During the past two months the plant has been operated on both distillates and residual stocks at throughputs which are 15 to 20 per cent higher than this average.

The dewaxing and deresining yields obtained during the first six months of 1938 are shown in Table 2.

The flexibility of the propane dewaxing process, as shown by the capacity and yield data on various stocks, is an important item in manufacturing cost. Most of the yield and operating cost savings which may be credited to the new dewaxing processes for Pennsylvania oils result from improved operation on residual stocks. However, the consolidation of distillate and residual dewaxing plants in one unit results in quite definite savings in labor and maintenance and in fixed costs.

Reduces Pay-Off Time

The ability of the propane dewaxing process to precipitate a portion of the coloring matter from the oil and reduce the decolorizing cost by about 30 per cent results in a reduction of the pay-off time for a 1,000-bbl. plant from about 2.6 to 2 years. Addition of a deresining step still further reduced this pay-off time by greatly reducing clay requirement with only a small decrease in finished oil production of a deresining step still further reduces this increases the percolation yield by approximately 100 per cent and decreases the decolorizing cost proportionately.

Using the operations of the present plant as a basis, it has been estimated that a propane deresining plant (without dewaxing) for handling 1,000 bbls. of cylinder stock per day would show a pay-off period of about 1.8 years as a result of savings in the cost of decolorizing by removing about 4 per cent of resins. These resins cannot be debited against the process because experience has shown that a large part of the material removed by deresining would normally have been taken out by the decolorizing step. A deresining plant could precipitate much more of the cylinder stock without appreciable increase in cost, but when the resin fraction amounts to more than 6 per cent the savings in clay alone will not always pay for the decrease in finished oil.

This point is shown by the operations to produce 13 per cent of resins, where the clay consumption was only 20 per cent of the requirement when using conventional dewaxing. Where the removal of 4 per cent resins reduced the clay consumption by 50 per cent, the removal of the additional 9 per cent reduced it to only 30 per cent with a net saving of only 35 cents per barrel and a net decrease of nearly 4 gallons of finished bright stock per barrel of charge. Obviously, if finished bright stock has a different value of 15 cents per gallon, this operation must depend on production of materials other than fuel from the resins, or on the increase in neutral equivalent. On the other hand, if the differential value is only 6 cents per gallon, the operation is economically justified even if the resins are discarded as fuel, and the increased neutral equivalent is an added advantage.

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Totals	2,055	51.173

Van Buren County

Bloomingdale Township (1s-14w)—Five producers, which added an estimated 2,300 bbls. daily potential, and two dry holes, summarized activity in Van Buren after the previous week's addition of 13 producers exceeding 10,000 bbls. daily. Midway sections of the Bloomingdale pool showed all the activity, with shallow production holding up among the new additions. The Bloomingdale pool shows the largest list of active drilling wells of any in Michigan, with 55 locations reported in various stages of completion. Some of these, however, have been shut down, owing to overproduction and weakened market conditions. Largest producer of the week in Bloomingdale was E. S. Shoemakers No. 1 Rodgers, NE SE NE Section 17, rated at 1,000 bbls. daily after acid. Bloomingdale Development Co. No. 1 Broughton, NW SE NE Section 17, was acidized to 700 bbls. daily. Prather & Hunt No. 1 Rumery, NW SE NE Section 17, gauged 300 bbls. daily after acid, and Bridger Basin Oil Co. No. 1 Brown, NE SE NE Section 17, was rated 250 bbls. daily naturally. M., R. & T. Oil Co. No. 1 Rowlinson, NW SW NW Section 16, rated as a small producer, gauged 50 bbls. after acid.

Hamilton Township (3s-15w)—A wildcat attempt to prove a producing vein southwest of Bloomingdale failed last week at Gulf Refining Co. No. 1 Wasylenski, SE SE SW Section 23, abandoned as dry.

December Lease Sale

Oil and gas leases on 11,236 acres of state-owned lands in Clare, Midland, Ogemaw, Roscommon and Gladwin counties will be auctioned December 2 by the lands division of the Michigan conservation department. Most of the acreage lies either in state forests or in state game refuges, 580 acres in areas already proved for oil production, the remainder wildcat.

Listed as wildcat territory are 3,247 acres in the Clare County end of Houghton Lake state forest, 1,809 acres in the Roscommon County end of the Houghton Lake forest, 3,750 acres in Midland County, of which 2,540 acres are in the Sanford game refuge, 520 acres in the Ogemaw game refuge in Ogemaw County, and 1,791 acres of cut-over pine forest lands in Roscommon County.

Good bonuses are expected by the conservation department on a 40-acre tract in Section 33-19n-6w, Midland County, and an 80-acre tract in Section 34-16n-1w, Clare County. In Gladwin County the proved offering is 640 acres on which leases have been surrendered because offsets were drilled in advance of the lessees' operations.

Small Pumping Well First Producer in Scotland

Decision has been reached to complete Anglo-American Oil Co. No. 1 Midlothian, near Dalkeith, Scotland, for a small pumping well, thus establishing it as the first commercial producer obtained in the broad scale exploration program in Great Britain.

At 2,200 feet No. 1 Midlothian tested for approximately 4,000,000 feet of gas with a closed-in pressure of 720 pounds. The hole was plugged back by stages to 2,100 feet, and finally to 2,050 feet. Casing was gun perforated from 1,730 to 1,760 feet to test the original showing of oil obtained last June in sand at 1,733 to 1,760 feet. While being swabbed through tubing for two hours each day the well is now yielding about 25 bbls. of fluid, half water and the remainder 32-degree A.P.I. oil. The test was drilled to total depth of 3,857 feet before plugging back and testing operations were ordered. Encouraged by the showing obtained in the first test, Anglo-American has moved its drilling rig to a new location about a half mile north and a little west for No. 2 Midlothian.

D'Arcy Exploration Co., subsidiary of Anglo Iranian, is preparing to start its No. 2 Cousland about 2 miles north of Anglo-American's second location.

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SHEAR-RELIEF VALVE

Canadian Fields

Completions and Operations in Northwest and in Ontario

By VICTOR LAURISTON

CHATHAM, Ontario, Nov. 12.—West of the proven Turner Valley field, Okalta Oil Co. No. 6, LSD 3, Section 30-18-2w5, finished in the black lime at 10,209 feet, a record depth for Canada, developed salt water from the main porous horizon after initial shows which indicated a good crude producer. This is the first time salt water has been struck in the lime formation in Turner Valley. Oil was used for drilling in the last stages, and when completed the well blew in with a strong initial showing, over 200 bbls. an hour. Later it ceased to flow, and high-pressure gas from a compressor was pumped into the hole, lifting a mixture of crude and salt water. Tests indicated the salt water was entering from the bottom of the hole, and that the upper porous horizon was free from water. Apparently some crude was coming with the water. The lower porous horizon and the overlying hard band of limestone were cemented, and the upper porous horizon, about 108 feet thick, will be acidized in the hope of developing commercial production.

While the upper porous horizon may develop a fair production, Okalta No. 6, which is 1½ miles west of the nearest crude producer, is regarded as definitely limiting the field to the west. Production at this point would have doubled the proven area.

Another outpost well west of the field, Anglo-Canadian Oil Co. No. 1, LSD 16, Section 31-18-2w5, finished around 8,200 feet after getting the Madison at about 7,786 feet. A preliminary test of the upper porous horizon yielded about 190 bbls. of 40-gravity crude, with indications of good gas pressure. When drilling was discontinued in the black lime after going through the lower porous horizon, the well blew in strongly and cleared itself nicely through the flare line. Gas pressure was not sufficient, however, and booster gas was brought in from the west flank wells to maintain production. It is 1 mile north and three-quarters of a mile east of Okalta No. 6, and about one-third mile west of the nearest crude producer. No production estimate will be given pending acidization.

In Section 16-18-2w5, Royal Canadian Oil Co. No. 2, LSD 4, finished in the lime at 7,195 feet, developed a natural potential of 2,784 bbls. a day, with gas-oil ratio 890 feet to the barrel. It was given an allowable of 468 bbls., the largest in the field.

In Section 29-18-2w5, Command Oils No. 1, LSD 14, offsetting Commoil No. 1 producer to the west, got the Madison limestone at 7,406 feet and cemented casing at 7,426 feet. It is deepening in the lime.

In Davies Petroleums No. 4, LSD 10, Section 32-18-2w5, finished at 7,236 feet

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in the lime, gas oil ratio of 1,300 feet has been considerably lowered by installing packer 100 feet from the bottom of the casing, and application will be made for a new official test.

West Flank Drilling

In the northwesterly extension of West Central Turner Valley, Sun Ray Oil Development Co. No. 1, LSD 8, Section 13-19-3w5, is below 2,485 feet. In Section 5-19-2w5, West Central Turner Valley, Royalite Oil Co. No. 34, LSD 7, is in the lime at 7,039 feet, and preparing to resume after cementing casing. Royalite No. 37, LSD 11, is below 2,779 feet. In Section 6-19-2w5, East Crest Oil Co. No. 4, LSD 8, bottoming at 2,430 feet, is cleaning out below 2,200 feet preparatory to running 10-inch casing.

In Section 32-18-2w5, Royalite Oil Co. No. 36, LSD 13-14, is below 3,565 feet. Vantage Oils No. 1, LSD 12, is making water shutoff at 176 feet. British Colonial Oils No. 1, LSD 5, is deepening after sidetracking lost tools and landing 13⅜-inch casing at 1,500 feet. West Turner Petroleums No. 3, LSD 6, is on top of the lime at 7,320 feet.

In Section 20-18-2w5, York Oils No. 2, LSD 6, is below 145 feet. Producers Crude Corp. No. 1, LSD 11, is in the Kootenay formation below 7,351 feet, after passing through the Home sand, and is getting close to the Madison. In Section 17-18-2w5, Extension Royalties No. 1, LSD 14, is below 6,217 feet. Anglo-Canadian Oil Co. No. 3, LSD 10, is below 5,748 feet, after getting the cardium marker at 4,984 feet. Anglo-Canadian No. 4, LSD 6, is working on cellar. In Section 16-18-2w5, Okalta Oil Co. No. 8, LSD 6, is below 2,620 feet.

In Section 9-18-2w5, D. & D. Oils No. 1, LSD 12, is in the lower Benton formation below 5,005 feet and believed to be through the cardium sandstone. George Harris and associates No. 1, LSD 13, same section, is rigging, with Snyder & Head handling the drilling contract.

West of the proven field, Scottish Petroleums No. 1, LSD 16, Section 19-18-2w5, is below 2,133 feet.

South Test May Resume

In the far south end of Turner Valley, Davies Petroleums No. 3, LSD 7, Section 33-17-2w5, may resume from 3,245 feet, where 10¾-inch casing was landed some months ago. While deep drilling is anticipated, it is expected that wells this far south of the proven field will encounter large production. It is about 2 miles south of National Petroleum No. 2, nearest crude producer.

In the southwesterly extension, Royalite Oil Co. No. 38 is preparing to start in LSD 16, Section 8-18-2w5, about a half mile west of National Petroleum Corp. No. 2 producer, and the most westerly yet made in the south end of the field.

North Turner Valley

In North Turner Valley, Royalite Oil Co. No. 35, LSD 7, Section 27-20-3w5, is below 5,425 feet. Home Oil Co. No. 2 Millarville, LSD 6, Section 33-20-3w5, is in the Fernie shales below 7,750 feet and getting close to the Madison limestone.

East Side Drilling

On the Calling Valley structure, east of Turner Valley, Sentinel Oil Co. No. 1, LSD 15, Section 8-20-2w5, is in a sand formation below 7,250 feet with small showings of heavy black crude, and some increase in gas.

On the Aldersyde structure, Ranchmen's Oil Co., LSD 16, Section 13-20-29w4, is resuming from 7,230 feet, after a shutdown of nearly a year. The test, financed largely by Calgary interests, has been drilling intermittently for over 10 years. Surface water was shut off at 61 feet, and no further water has been encountered. Numerous small gas shows were met on the way down, and at 6,263 feet white oil was struck in the grit beds. Brown crude was bailed in fair quantities from another sand at 6,660 feet, and just above 7,230 feet high-grade sweet green crude was encountered. At this depth the test is in the Dalhousie formation, with the Madison limestone expected around 7,350 feet.

Tests in the Foothills

On the Brazeau structure, in the northern foothills west of Edmonton, Home Oil Co. No. 1, LSD 16, Section 7-43-17w5, has casing down to 3,550 feet and is cleaning to bottom at 4,520 feet.

On the Ram River structure west of Rocky Mountain House, Ram River Oils No. 1 Township 38-12w5, is in the Banff shales below 56 feet with the Devonian limestone expected around 200 feet.

On the Clearwater structure, Altoba No. 1, Section 31-34-9w5, is below 1,027 feet and more than 770 feet in the Devonian limestone.

On the Moose dome, Moose Oils No. 2, LSD 8, Section 29-22-6w5, is fishing around 1,690 feet preparatory to deepening to about 1,910 feet where additional production is expected. Some light crude is being bailed at intervals, with about 1,250 bbls. in storage on the lease.

On the Grease Creek structure road work has been finished and equipment is being moved to location for No. 1 test by Frank McMahon and associates, to spud about December 1.

On the Highwood-Sinclair structure, southwest of Turner Valley, Green Valley Oils No. 1 Banner, LSD 6, Section 34-17-3w5, is in a hard buff lime below 6,336 feet, more than 976 feet in the Madison, with additional gas and light crude showings.

On the Watson structure, Mar Jon Oil Co. No. 3, LSD 3, Section 4-10-2w5, is in the lower Blairmore formation below 6,120 feet.

Highwood-Sarcee Prospects

On the Highwood-Sarcee Indian Reserve near Calgary, structure tests for Highwood-Sarcee Oils, Ltd., covering a permit area of about 30,000 acres have been completed. Testing, under the direction of Dr. T. B. Williams, continued from June to August and results are being studied with a view to mapping a drilling program.

Anglo-Canadian Operations

In addition to drilling in Turner Valley, Anglo-Canadian Oil Co. of Calgary has secured approximately 90,000 acres located on five different southern Alberta structures. In the southern foothills, some 22,000 acres on the Savannah Creek structure, 25 miles southwest of Turner Valley, will be tested by No. 1, SW quarter Section 20-14-4w5, and diamond drill is being moved to location. In the Pincher Creek area, Anglo-Canadian No. 1 on the Castle Hill structure has derrick up in LSD 4, Section 11-6-1w5. The company holds some 9,000 acres leased from Paul von Weymarn. On the Bridge dome structure, where the company holds 3,500 acres, Anglo-Canadian No. 1 Milk River, LSD 10, Section 4-2-13w4, is deepening after cementing casing at 1,950 feet.

On the Steveville structure in southern Alberta, a test will be started this fall on a location south of Anaconda Oil Co. No. 1. Plans are also being made for

(Continued on Page 257)

HOW Pensacola, Fla. GOT MORE WATER FOR $3,000 A YEAR LESS COST

U. S. NAVY PHOTO
Courtesy Pensacola Municipal Adv. Board

OLD WELLS and out of date pumping equipment could not produce an adequate supply of water. Power cost was excessive. The City of Pensacola was growing rapidly. Mains were being extended. Something had to be done.

Layne engineers surveyed the situation. Their recommendations were accepted. The Layne-Central Company (one of the Layne & Bowler, Inc., affiliates) installed and equipped a 26 inch well that gave Pensacola 3,600,000 gallons of water per day. Power cost alone, saved over $3,000.00 a year. Another 26 inch Layne Well was installed to give them a 100 per cent "standby" supply of water. Thus they are not only saving money, but are getting more and better water. Both wells are gravel wall, underreamed type and concrete sealed from strainer to ground level against seepage and unwanted intermediate water strata.

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Summary of Operations, All Fields, October

SUMMARY OF OPERATIONS

Wells Completed

	Comp.	Prod.	Dry	Gas
Eastern fields	272	383	21	65
Lima	3	50	1	0
Central Ohio	72	215	25	32
Indiana	20	190	8	7
Illinois	402	102,203	71	3
Michigan	138	56,421	54	6
East. Kentucky	24	125	6	5
West. Kentucky	81	7,195	32	4
Kansas	121	37,199	23	1
Oklahoma	110	17,780	40	9
N. Cent. Texas	200	48,648	79	2
E. Cent. Texas	24	2,709	6	1
East Texas	90	4,359	2	1
East Tex. border	8	840	2	2
West Texas	148	128,876	18	1
Tex. Panhandle	42	13,723	2	5
Southwest Texas	256	29,901	82	9
Tex. Gulf Coast	127	44,885	15	7
La. Gulf Coast	42	10,903	11	1
North Louisiana	46	4,215	20	7
Arkansas	20	10,630	1	2
Mississippi	2	0	2	0
Montana	11	688	3	2
Wyoming	17	4,596	3	1
Colorado	3	180	1	0
New Mexico	57	15,730	7	1
Ttl. Oct.	2,336	617,430	535	174
Ttl. Sept.	2,218	430,156	531	160
Difference	118	187,274	4	6

Rigs and Wells Drilling

	Rigs	Drlg.	Ttl.
Eastern fields	70	273	343
Lima	2	9	11
Central Ohio	33	105	138
Indiana	1	43	44
Illinois	60	314	374
Michigan	24	118	142
Eastern Kentucky	4	34	38
Western Kentucky	0	85	85
Kansas	22	179	201
Oklahoma	42	268	310
North Central Texas	83	228	311
East Central Texas	6	42	48
East Texas	19	36	55
East Texas border	9	10	19
West Texas	67	274	341
Texas Panhandle	15	91	106
Southwest Texas	30	213	243
Texas Gulf Coast	17	101	118
Louisiana Gulf Coast	14	113	127
North Louisiana	32	60	92
Arkansas	18	33	51
Mississippi	7	3	10
Florida	2	0	2
Montana	1	55	56
Wyoming	4	67	71
Colorado	1	32	33
New Mexico	13	139	152
Utah	1	4	5
Nebraska	3	6	9
Ttl. Oct.	600	2,935	3,535
Ttl. Sept.	588	2,935	3,523
Difference	12	0	12

KANSAS

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Barber	0	0	0	0	1	1
Barton	21	9,029	1	0	3	25
Butler	7	405	1	0	0	8
Coffey	1	0	1	0	0	1
Cowley	8	728	3	0	1	13
Ellis	7	4,715	0	0	2	9
Ellsworth	8	3,477	1	0	0	1
Graham	1	0	1	0	0	0
Grant	0	0	0	0	0	1
Greenwood	5	49	2	0	1	9
Harvey	0	0	0	0	1	2
Kingman	0	0	0	0	0	1
Marion	0	0	0	0	1	4
McPherson	3	185	1	0	0	9
Meade	0	0	0	0	0	1
Ness	0	0	0	0	0	2
Norton	0	0	0	0	0	1
Ottawa	0	0	0	0	0	1
Pottawatomie	0	0	0	0	0	1
Pratt	2	265	1	0	0	2
Reno	1	320	0	0	0	5
Rice	14	6,012	1	0	2	15
Rooks	2	65	0	0	0	3
Rush	1	0	1	0	0	0
Russell	12	5,067	2	0	3	22
Saline	0	0	0	0	0	1
Scott	0	0	0	0	0	1
Sedgwick	3	146	2	0	1	8
Stafford	16	6,673	1	0	5	22
Stevens	0	0	0	1	0	0
Sumner	0	0	0	0	0	4
Thomas	0	0	0	0	0	1
Wabaunsee	0	0	0	0	0	1
Woodson	9	63	4	0	1	4
Ttl. Oct.	121	37,199	23	1	22	179
Ttl. Sept.	167	39,479	42	5	21	184
Difference	46	2,280	19	4	1	5

OKLAHOMA

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Atoka	0	0	0	0	0	1
Beckham	2	0	0	2	0	0
Caddo	4	2,115	1	1	4	11
Carter	5	36	2	0	1	13
Choctaw	0	0	0	0	0	1
Cleveland	0	0	0	0	1	2
Coal	1	0	1	0	0	3
Comanche	2	0	2	0	0	3
Creek	2	150	1	0	2	28
Garfield	1	0	1	0	0	2
Garvin	1	0	1	0	0	1
Grady	1	0	1	0	1	3
Hughes	0	0	0	0	1	5
Jackson	0	0	0	0	0	2
Jefferson	1	10	0	0	0	1
Kay	1	0	1	0	0	5
Kingfisher	0	0	0	0	0	1
Kiowa	1	0	1	0	0	3
Latimer	1	0	0	1	0	0
Lincoln	2	50	1	0	1	7
Logan	0	0	0	0	1	3
Love	1	0	1	0	0	0
Marshall	1	0	1	0	0	1
McClain	0	0	0	0	0	1
Murray	0	0	0	0	0	1
Muskogee	5	0	3	2	1	7
Noble	2	740	1	0	1	2
Okfuskee	5	195	3	0	1	5
Oklahoma	0	0	0	0	4	8
Okmulgee	13	51	7	0	3	28
Osage	4	58	2	0	1	17
Pawnee	0	0	0	0	0	3
Payne	3	3,221	0	0	1	1
Pittsburg	0	0	0	0	0	3
Pontotoc	6	3,860	0	0	3	16
Pottawatomie	20	5,244	3	0	6	37
Seminole	12	1,155	1	0	7	21
Stephens	7	440	4	1	1	7
Tillman	1	377	0	0	0	2
Texas	2	0	0	2	0	3
Tulsa	2	3	1	0	1	5
Wagoner	1	75	0	0	0	3
Washita	0	0	0	0	0	2
Ttl. Oct.	110	17,780	40	9	42	268
Ttl. Sept.	175	21,513	55	9	39	287
Difference	65	3,733	15	0	3	19

WEST CENTRAL AND NORTH TEXAS

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Archer	15	2,749	7	0	6	15
Baylor	0	0	0	0	0	2
Brown	10	126	6	0	0	12
Callahan	3	0	2	1	5	2
Clay	15	546	6	0	1	6
Coleman	2	0	2	0	0	9
Comanche	2	33	0	0	1	3
Cooke	11	272	4	0	2	8
Denton	0	0	0	0	1	3
Erath	0	0	0	0	0	2
Eastland	2	15	0	0	1	5
Fisher	2	325	1	0	0	3
Foard	0	0	0	0	0	1
Hamilton	0	0	0	0	0	2
Haskell	1	0	1	0	1	3
Jack	10	613	7	0	7	11
Johnson	0	0	0	0	0	1
Jones	14	3,273	6	0	1	22
Knox	0	0	0	0	0	1
Montague	4	180	2	0	0	4
Palo Pinto	0	0	0	0	1	5
Parker	3	0	3	0	0	3
Shackelford	9	698	6	0	0	13
Stephens	1	0	0	1	2	3
Tarrant	0	0	0	0	0	2
Taylor	2	188	1	0	0	2
Throckmorton	0	0	0	0	0	5
Wichita	64	32,695	12	0	42	48
Wilbarger	2	796	0	0	2	3
Wise	0	0	0	0	1	5
Young	28	6,139	13	0	9	24
Total Oct.	200	48,648	79	2	83	228
Total Sept.	234	57,054	76	6	64	233
Difference	34	8,406	3	4	19	5

COASTAL LOUISIANA

Summary of Field Operations

Field—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Abbeville	1	0	1	0	1	0
Bayou Blue	0	0	0	0	1	0
Bancroft	0	0	0	0	0	3
Bateman Lake	0	0	0	0	0	1
Bay St. Elaine	2	728	0	0	0	0
Bayou Cocotriz	0	0	0	0	0	1
Bayou Des Allemands	1	0	1	0	0	1
Big Lake	0	0	0	0	0	1
Black Bayou	0	0	0	0	0	1
Caillou Island	0	0	0	0	0	1
Cameron Meadows	1	0	1	0	0	2
Creole	0	0	0	0	0	1
Chacahoula	0	0	0	0	0	1
Charenton	1	300	0	0	0	2
Choctaw	1	780	0	0	2	0
Darrow	0	0	0	0	0	2
Dog Lake	1	418	0	0	0	1
East Baton Rouge	0	0	0	0	0	2
Edgerly	0	0	0	0	0	2
Fausse Point	0	0	0	0	0	1
Four Isle	0	0	0	0	0	1
Garden Island	0	0	0	0	0	1
Gillis	1	153	0	0	0	1
Grand Bay	1	155	0	0	0	1
Gueydan	0	0	0	0	0	2
Hackberry	5	1,519	1	1	1	7
Horseshore Bayou	0	0	0	0	0	1
Jeanerette	1	454	0	0	1	0
Jefferson Island	0	0	0	0	0	1
Jennings	6	698	2	0	1	14
Lafitte	2	2,164	0	0	0	4
Lake Barre	0	0	0	0	0	1
Lake Long	1	567	0	0	0	1
Lake Pelto	0	0	0	0	0	1
Leesville	2	43	1	0	0	2
Lirette	1	45	0	0	0	1
Lockport	1	51	0	0	0	1
North Crowley	0	0	0	0	0	1
North Tepetate	1	85	0	0	1	0
New Iberia	2	1,253	0	0	0	5
Port Barre	0	0	0	0	0	2
Potash	0	0	0	0	0	2
Quarantine Bay	2	496	0	0	0	1
Raceland	0	0	0	0	0	4
South Roanoke	1	307	0	0	0	1
Sorrento	0	0	0	0	1	0
Starks	1	0	1	0	0	0
Sulphur	0	0	0	0	0	4
Timbalier Bay	0	0	0	0	0	1
Valentine	1	149	0	0	0	2
Venice	0	0	0	0	0	1
Villa Platte	1	375	0	0	0	6
Vinton	0	0	0	0	0	1
West Gueydan	0	0	0	0	0	1
Woodlawn	1	163	0	0	0	1
Miscellaneous	3	0	3	0	5	17
Ttl. Oct.	42	10,903	11	1	14	113
Ttl. Sept.	45	10,840	17	1	23	102
Difference	3	63	6	0	9	11

WEST TEXAS

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Andrews	2	4,451	1	0	3	18
Brewster	0	0	0	0	0	1
Cochran	2	0	2	0	0	1
Coke	0	0	0	0	0	1
Crane	6	7,394	1	0	4	10
Crockett	0	0	0	0	1	2
Culberson	0	0	0	0	0	4
Concho	1	0	1	0	0	2
Dawson	0	0	0	0	0	1
Ector	48	64,417	0	0	5	62
El Paso	1	0	0	0	0	1
Gaines	4	1,204	2	0	0	4
Garza	0	0	0	0	0	1
Glasscock	0	0	0	0	0	1
Hockley	2	1,016	0	0	0	3
Howard	12	7,985	2	0	7	22
Hudspeth	0	0	0	0	0	2
Irion	0	0	0	0	0	1
Jeff Davis	0	0	0	0	0	1
Kent	0	0	0	0	0	1
Kimble	0	0	0	0	0	2
Lynn	0	0	0	0	0	1
Menard	0	0	0	0	0	1
Martin	0	0	0	0	0	1
McCulloch	1	0	1	0	0	1
Nolan	0	0	0	0	0	2
Pecos	11	2,315	4	0	15	30
Presidio	0	0	0	0	0	2
Reagan	0	0	0	0	0	1
Reeves	1	0	0	1	0	2
Runnels	0	0	0	0	0	3
Schleicher	0	0	0	0	0	1
Scurry	0	0	0	0	3	2
Sterling	0	0	0	0	0	1
Stonewell	1	0	1	0	0	1
Sutton	0	0	0	0	0	1
Terrell	0	0	0	0	0	1
Tom Green	0	0	0	0	0	3
Upton	11	5,502	2	0	7	17
Val Verde	0	0	0	0	0	1
Ward	15	9,105	1	0	9	18
Winkler	14	13,548	0	0	5	12
Yoakum	17	11,939	0	0	8	31
Ttl. Oct.	148	128,876	18	1	67	274
Ttl. Sept.	149	109,718	19	2	73	276
Difference	1	19,158	1	1	6	2

SOUTHWEST TEXAS

Summary of Field Operations

Field—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Agua Dulce	1	40	0	0	0	3
Alice (South)	12	1,521	1	0	1	8
Alfred	1	0	1	0	0	0
Alta Vista	0	0	0	0	0	1
Armagosa	0	0	0	0	0	1
Alta Verde	1	42	0	0	0	0
Barbacoas	1	0	0	1	0	1
Banderia	0	0	0	0	0	1
Benavides	6	630	0	0	2	4
Branyon	2	68	0	0	0	1
Bruni	1	12	0	0	0	1
Byersville	1	0	1	0	0	0
Callihan	2	7	1	0	0	1
Campana	1	20	0	0	1	0
Charco Rendondo	2	0	2	0	0	0
Church	0	0	0	0	0	1
Casa Blanca	7	127	1	3	0	1
Charamousa	1	0	1	0	0	1
Chicon Lake	1	3	0	0	0	1
Chapm'n Rch.	1	0	1	0	0	0
C. Driscoll	3	309	0	0	1	4
Comitas	3	56	1	0	0	0
Dale	3	0	3	0	1	0
Darst Creek	5	560	1	0	1	6
Driscoll	1	66	0	0	0	1
Dunlap	0	0	0	0	0	1
Eagle Hill	7	418	0	1	0	2
E. Placedo	2	322	0	0	0	2
E. Premont	0	0	0	0	0	1
Escobas	4	85	2	0	0	2
E. Wh. Point	4	470	0	0	0	3
Ezzell	4	1,256	1	0	0	3
Fitzsimmons	10	1,366	1	0	1	7
Flour Bluff	0	0	0	0	1	0
Heyser	9	1,402	1	0	1	4
Hoffman	20	3,256	1	0	2	8
Ina	0	0	0	0	0	1
Jacob	2	0	2	0	0	0
Kelsey	0	0	0	0	0	1
Junction	1	10	0	0	0	0
Labbe	0	0	0	0	0	1
Keeran	1	116	0	0	0	2
Las Animas	2	132	0	0	0	1
La Reforma	1	50	0	0	0	0
La Rosa	2	288	0	0	1	3
Loma Valdez	0	0	0	0	0	1
Los Piachos	1	0	1	0	0	0
Luby	8	962	0	0	1	4
Luling	1	15	0	0	0	2
Lundell	1	96	0	0	0	2
Margo	0	0	0	0	0	2
McCampbell	3	317	0	0	2	3
McFaddin	1	0	0	1	0	3
Mercedes	0	0	0	0	0	1
Mirando Vly.	1	15	0	0	0	1
Munson	6	0	6	0	0	3
Oakville	0	0	0	0	0	1
O'Hern	1	62	0	0	0	0
Oilton	1	65	0	0	0	0
Piedra Pintas	0	0	0	0	0	1
Plymouth	2	239	0	0	0	3
Rancho Solo	1	100	0	0	0	2
Refugio	5	617	0	0	0	3
Ricaby	2	100	0	0	0	0
Richard King	1	116	0	0	0	1
Riddle	1	420	0	0	1	0
Sacatosa	1	0	0	1	0	1
Salt Flats	4	202	0	0	0	4
Samfordyce	3	328	0	0	1	4
San Jose	1	0	1	0	0	1
Saxet	5	473	1	0	2	9
Seven Sisters	2	59	1	0	0	0
S. Burnell	1	0	1	0	0	0
S. Callihan	0	0	0	0	0	1
South C. Driscoll	1	70	0	0	0	1
Somerset	1	0	0	1	0	0
Stratton	0	0	0	0	0	2
Sun	0	0	0	0	0	3
Sweden	1	0	1	0	0	1
Telferner	0	0	0	0	0	2
Tesoro	2	108	1	0	0	0
Tomoconnor	17	12,492	0	0	1	8
Tulsita	2	3	0	1	1	0
Von Ormy	3	9	0	0	0	0
West Saxet	4	401	0	0	0	4
Misc.	47	0	47	0	8	60
Ttl. Oct.	256	29,901	82	9	30	213
Ttl. Sept.	197	25,340	53	6	31	194
Difference	59	4,561	29	3	1	19

EAST CENTRAL AND EAST TEXAS

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Anderson	3	274	0	0	0	8
Angelina	1	0	1	0	0	1
Cherokee	0	0	0	0	0	2
Dallas	0	0	0	0	0	1
Delta	1	0	1	0	0	0
Falls	0	0	0	0	0	1
Franklin	3	402	0	0	0	1
Freestone	4	534	1	0	2	4
Grayson	1	288	0	0	1	3
Gregg	52	2,494	1	1	8	15
Henderson	2	56	1	0	1	2
Houston	2	26	0	0	0	2
Kaufman	1	0	1	0	1	2
Lamar	0	0	0	0	0	1
Leon	2	0	1	1	0	1
McLennan	0	0	0	0	0	3
Madison	0	0	0	0	0	1
Navarro	0	0	0	0	0	1
Red River	0	0	0	0	1	4
Rusk	23	1,221	1	0	7	7
Smith	2	116	0	0	2	3
Titus	4	1,129	0	0	0	1
Trinity	0	0	0	0	0	2
Upshur	13	528	0	0	2	9
Van Zandt	0	0	0	0	0	3
Ttl. Oct.	114	7,068	8	2	25	78
Ttl. Sept.	120	6,735	13	3	36	82
Difference	6	333	5	1	11	4

TEXAS PANHANDLE

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Carson	4	180	1	2	1	9
Collingsw'th	0	0	0	0	1	2
Deaf Smith	0	0	0	0	1	1
Donley	0	0	0	0	0	1
Dickens	1	0	1	0	0	3
Floyd	0	0	0	0	0	1
Gray	12	4,371	0	0	4	16
Hall	0	0	0	0	0	1
Hutchinson	24	9,172	0	2	7	39
Lipscomb	0	0	0	0	0	1
Moore	1	0	0	1	0	9
Potter	0	0	0	0	0	1
Roberts	0	0	0	0	0	2
Wheeler	0	0	0	0	1	5
Ttl. Oct.	42	13,723	2	5	15	91
Ttl. Sept.	32	8,789	3	6	16	93
Difference	10	4,934	1	1	1	2

TEXAS GULF COAST

Summary of Field Operations

Field—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Amelia	0	0	0	0	0	1
Anahuac	5	3,031	0	0	0	2
Batson	1	264	0	0	0	1

Bay City	1	200	0	0	0	2
Barbers Hill	0	0	0	0	0	2
Cedar Point	2	1,169	0	0	1	0
Cheek	0	0	0	0	0	1
Clam Lake	1	153	0	0	0	1
Clinton	1	278	0	0	0	0
Clear Lake	0	0	0	0	0	1
Cotton Lake	6	961	1	0	0	3
Cordelle	2	543	0	0	0	1
Danbury	0	0	0	0	0	3
Dickinson	9	5,157	0	0	2	6
Eureka	1	476	0	0	0	2
Esperson	0	0	0	0	0	1
Fairbanks	13	7,703	0	1	2	8
Friendswood	10	5,019	1	0	1	4
Greens Lake	0	0	0	0	0	1
Hankamer	0	0	0	0	0	1
Hardin	11	4,247	0	0	2	4
Hastings	12	5,489	0	0	1	3
Hitchcock	3	1,041	0	0	0	1
Humble	0	0	0	0	0	1
Katy	4	0	0	4	0	0
League City	1	301	0	0	0	2
Lockridge	0	0	0	0	0	1
Labelle	0	0	0	0	0	1
Magnet	0	0	0	0	0	2
Manvel	0	0	0	0	0	1
McClosky	1	0	1	0	0	0
North Cheek	0	0	0	0	0	1
North Markham	0	0	0	0	0	1
Old Ocean	2	775	0	0	0	5
Orchard	0	0	0	0	0	1
Orange	4	831	1	0	1	5
Seabreeze	1	624	0	0	1	1
Sandy Point	0	0	0	0	0	1
Segno	3	1,108	0	0	1	1
Silsbee	0	0	0	0	0	1
South Anahuac	1	0	0	1	0	0
Spindletop	1	313	0	0	1	0
South Houston	0	0	0	0	1	0
Spurger	1	549	0	0	1	0
Thompson	4	300	2	0	0	2
Tomball	8	2,249	0	1	0	3
Turtle Bay	0	0	0	0	0	1
Van Vleck	0	0	0	0	1	0
West Columbia	4	1,615	0	0	0	4
West Ranch	1	37	0	0	0	1
Withers	4	452	0	0	0	3
Miscellaneous	9	0	9	0	1	13
Ttl. Oct.	127	44,885	15	7	17	101
Ttl. Sept.	121	43,223	24	2	20	100
Difference	6	1,662	9	5	3	1

NORTH LOUISIANA

Summary of Field Operations

Parish—	Comp.	Prod.	Dry	Gas	*Rgs.	Dig.
Bienville	0	0	0	0	0	2
Bossier	5	350	0	0	2	4
Caddo-Rodessa	0	0	0	0	0	0
Caddo-other	15	1,880	6	1	7	14
Caldwell	0	0	0	0	1	0
Catahoula	0	0	0	0	1	0
Claiborne	0	0	0	0	0	3
Concordia	1	0	1	0	1	0
De Soto	2	0	2	0	4	1
Grant	1	0	1	0	3	1
LaSalle	1	15	0	0	2	1
Morehouse	1	0	0	1	0	0
Natchitoches	1	0	1	0	0	0
Red River	4	0	4	0	1	2
Sabine	7	35	5	0	6	8
Tensas	0	0	0	0	0	1
Union	3	0	0	3	3	1
Webster	5	1,935	0	2	1	22
Ttl. Oct.	46	4,215	20	7	32	60
Ttl. Sept.	47	5,575	9	14	34	65
Difference	1	1,360	11	7	2	5

*Gas production: Caddo Parish, 3,470,000 feet; Morehouse, 4,500,000 feet; Union, 17,000,000 feet; Webster, 9,000,000 feet.

ARKANSAS

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	*Rgs.	Dig.
Calhoun	0	0	0	0	2	0
Columbia	1	190	0	1	0	5
Craighead	0	0	0	0	1	0
Lincoln	0	0	0	0	1	0
Little River	0	0	0	0	4	1
Lonoke	0	0	0	0	2	2
Madison	0	0	0	0	1	0
Miller-Rodessa	1	550	0	0	1	2
Mississippi	0	0	0	0	1	0
Nevada	0	0	0	0	0	2
Ouachita	0	0	0	0	0	1
Pike	0	0	0	0	0	1
Pulaski	0	0	0	0	2	0
Union	18	9,890	1	1	3	19
Ttl. Oct.	20	10,630	1	2	18	33
Ttl. Sept.	22	6,965	6	0	13	39
Difference	2	3,665	5	2	5	6

*Gas production: Columbia County, 4,000,000 feet; Union County, 1,500,000 feet.

MISSISSIPPI

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Calhoun	0	0	0	0	2	0
George	0	0	0	0	1	0
Harrison	0	0	0	0	1	0
Hinds	0	0	0	0	1	2
Rankin	0	0	0	0	0	1
Simpson	0	0	0	0	2	0
Wilkinson	1	0	1	0	0	0
Yalobusha	1	0	1	0	0	0
Ttl. Oct.	2	0	2	0	7	3
Ttl. Sept.	1	0	0	1	6	4
Difference	1	0	2	1	1	1

EAST TEXAS BORDER

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	*Rgs.	Dig.
Cass-Rodessa	1	190	0	0	1	0
Cass-other	1	0	1	0	0	0
Harrison	0	0	0	0	1	2
Marion-Rodessa	4	650	0	1	3	7
Marion-other	1	0	1	0	2	0
Panola	1	0	0	1	0	0
Sabine	0	0	0	0	2	0
Shelby	0	0	0	0	0	1
Ttl. Oct.	8	840	2	2	9	10
Ttl. Sept.	8	2,215	0	0	4	14
Difference	0	1,375	2	2	5	4

*Gas production: Panola County, 3,000,000 feet; Marion County, 33,000,000 feet.

FLORIDA

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Lake	0	0	0	0	1	0
Nassau	0	0	0	0	1	0
Ttl. Oct.	0	0	0	0	2	0
Ttl. Sept.	0	0	0	0	2	0
Difference	0	0	0	0	0	0

ROCKY MOUNTAIN AREA

New Mexico

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Bernalillo	0	0	0	0	0	2
McKinley	1	150	0	0	0	5
Rio Arriba	1	0	1	0	0	1
San Juan	2	0	2	0	0	9
San Miguel	0	0	0	0	0	3
Socorro	0	0	0	0	0	1
Torrance	1	0	0	1	0	2
Valencia	0	0	0	0	0	3
Lea	47	15,283	3	0	12	83
Eddy	5	297	1	0	1	23
Chaves	0	0	0	0	0	4
DeBaca	0	0	0	0	0	2
Roosevelt	0	0	0	0	0	1
Ttl. Oct.	57	15,730	7	1	13	139
Ttl. Sept.	59	9,425	8	1	15	121
Difference	2	6,285	1	0	2	18

Montana

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Big Horn	0	0	0	0	1	2
Blaine	1	0	1	0	0	1
Carbon	0	0	0	0	0	6
Fergus	0	0	0	0	0	5
Glacier	7	658	0	2	0	6
Hill	0	0	0	0	0	2
Judith Basin	0	0	0	0	0	2
Petroleum	0	0	0	0	0	4
Pondera	1	0	1	0	0	1
Teton	1	0	1	0	0	2
Toole	0	0	0	0	0	12
Yellowstone	1	30	0	0	0	2
Miscellaneous	0	0	0	0	0	10
Ttl. Oct.	11	688	3	2	1	55
Ttl. Sept.	14	526	4	1	4	51
Difference	3	162	1	1	3	4

Utah

Summary of Field Operations

	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Ttl. Oct.	0	0	0	0	1	4
Ttl. Sept.	0	0	0	0	1	4
Difference	0	0	0	0	0	0

Colorado

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Adams	0	0	0	0	0	2
Archuleta	0	0	0	0	0	2
Elbert	0	0	0	0	0	1
Grand	1	0	1	0	0	0
La Plata	0	0	0	0	0	2
Las Animas	0	0	0	0	0	2
Mesa	0	0	0	0	0	2
Moffat	2	180	0	0	0	3
Park	0	0	0	0	0	2
Prowers	0	0	0	0	0	1
Pueblo	0	0	0	0	1	2
Rio Blanco	0	0	0	0	0	1
Routt	0	0	0	0	0	3
Miscellaneous	0	0	0	0	0	8
Ttl. Oct.	3	180	1	0	1	31
Ttl. Sept.	2	5	1	0	3	32
Difference	1	175	0	0	2	1

Wyoming

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dig.
Big Horn	0	0	0	0	1	7
Carbon	4	242	2	0	0	5
Converse	1	0	1	0	0	10
Fremont	0	0	0	0	0	6

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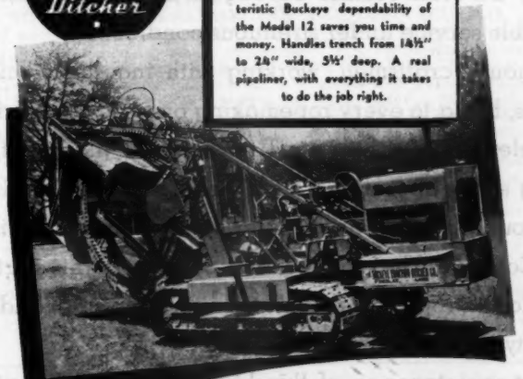

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Hot Springs	1	96	0	0	0	2
Lincoln	0	0	0	0	0	2
Natrona	0	0	0	0	0	3
Niobrara	3	4,031	0	0	2	7
Park	1	0	0	1	1	2
Sublette	1	52	0	0	0	4
Sweetwater	1	100	0	0	0	3
Uinta	0	0	0	0	0	2
Washakie	0	0	0	0	0	2
Weston	5	75	0	0	0	8
Miscellaneous	0	0	0	0	0	4
Ttl. Oct.	17	4,596	3	1	4	67
Ttl. Sept.	9	389	3	0	7	66
Difference	8	4,207	0	1	3	1

WESTERN KENTUCKY

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Breckenridge	3	0	2	1	0	1
Butler	14	165	6	0	0	9
Caldwell	1	0	1	0	0	0
Daviess	22	3,130	7	0	0	25
Grayson	3	0	2	1	0	2
Hancock	6	60	1	1	0	6
Henderson	12	3,720	4	0	0	19
Hopkins	0	0	0	0	0	2
McLean	2	30	1	0	0	4
Muhlenbrug	0	0	0	0	0	1
Ohio	16	90	6	1	0	15
Union	0	0	0	0	0	1
Webster	2	0	2	0	0	0
Ttl. Oct.	81	7,195	32	4	0	85
Ttl. Sept.	86	7,235	42	1	0	85
Difference	5	40	10	3	0	0

EASTERN KENTUCKY

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Lawrence	1	3	0	0	0	0
Lee	5	35	1	0	0	4
Powell	3	31	0	0	1	5
Elliott	1	5	0	0	0	1
Magoffin	2	3	0	0	0	1
Floyd	6	38	2	3	0	3
Martin	4	10	1	2	2	10
Knott	1	0	1	0	1	5
Pike	1	0	1	0	0	3
Wolfe	0	0	0	0	0	2
Ttl. Oct.	24	125	6	5	4	34
Ttl. Sept.	13	64	2	6	0	32
Difference	11	61	4	1	4	2

ILLINOIS

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Bond	1	0	1	0	0	6
Brown	0	0	0	0	0	1
Christian	2	0	2	0	0	0
Clay	33	14,515	2	0	2	13
Crawford	0	0	0	0	0	1
Coles	2	0	2	0	1	1
Clark	2	15	1	0	0	2
Clinton	26	1,440	5	0	3	46
Cumberland	2	0	2	0	0	1
Champaign	0	0	0	0	1	3
Dewitt	0	0	0	0	0	2
Edwards	0	0	0	0	0	1
Edgar	0	0	0	0	3	3
Effingham	2	0	2	0	0	0
Fayette	137	27,339	12	0	22	83
Franklin	1	0	1	0	0	1
Fulton	0	0	0	0	0	1
Gallatin	0	0	0	0	0	1
Hamilton	0	0	0	0	0	2
Jefferson	12	1,751	5	0	0	6
Johnson	0	0	0	0	0	1
Lawrence	6	50	2	3	4	9
Massac	0	0	0	0	0	1
Madison	1	0	1	0	0	1
Marion	139	48,712	17	0	16	79
Macoupin	0	0	0	0	0	1
Menard	0	0	0	0	0	1
McDonough	1	0	1	0	0	4
Moultrie	2	0	2	0	0	0
Montgomery	1	0	1	0	0	1
Morgan	1	0	1	0	0	0
Perry	0	0	0	0	0	0
Piatt	0	0	0	0	1	1
Pike	0	0	0	0	0	1
Pope	0	0	0	0	0	1
Randolph	0	0	0	0	0	5
Richland	9	1,828	2	0	1	8
Saline	0	0	0	0	0	3
St. Clair	1	0	1	0	0	0
Shelby	2	0	2	0	1	4
Washington	2	0	2	0	0	0
Williamson	0	0	0	0	0	1
Wabash	2	0	2	0	1	3
Wayne	15	6,568	2	0	3	15
White	0	0	0	0	1	0
Ttl. Oct.	402	102,203	71	3	60	314
Ttl. Sept.	258	49,114	62	2	38	319
Differ.	144	53,089	19	1	22	5

MICHIGAN

Summary of Field Operations

Field—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Adams	0	0	0	0	0	3
Bentley	0	0	0	0	1	4
Bloomingdale	34	17,099	9	0	5	9
Buckeye	1	182	0	0	0	3
Clayton	1	0	1	0	1	1
Deerfield	0	0	0	0	0	1
Dorr	1	95	0	0	1	2
Edenville	1	396	0	0	0	4
Edmore	2	0	1	1	0	0
Freeman	14	32,450	1	0	7	27
Freeman Gas	1	0	0	1	0	1
Lincoln	0	0	0	0	0	1
Loomis	0	0	0	0	0	1
Monterey	1	110	0	0	0	1
Overisel	16	0	0	2	0	1
Salem	9	1,450	2	0	1	3
Sherman	1	215	0	0	0	3
Skunk Lake	0	0	0	0	0	0
Stewart	10	4,040	1	0	2	2
Trowbridge	1	10	0	0	0	2
West Branch	2	74	0	0	1	4
Winegars	1	100	0	0	1	1
Winfield	2	0	0	2	1	0
Wise	0	0	0	0	0	1
Wisner	0	0	0	0	0	2
14-15-14w	1	200	0	0	0	0
Wildcats	39	0	39	0	3	31
Ttl. Oct.	138	56,421	54	6	24	118
Ttl. Sept.	83	28,288	35	1	39	130
Difference	55	28,133	19	5	15	12

INDIANA

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Blackford	0	0	0	0	0	1
Crawford	0	0	0	0	0	2
Daviess	1	0	0	1	0	1
Decatur	1	0	0	1	0	1
DeKalb	0	0	0	0	0	1
Gibson	1	0	1	0	0	1
Greene	0	0	0	0	0	1
Harrison	0	0	0	0	0	2
Huntington	0	0	0	0	0	1
Jasper	1	0	1	0	0	0
Knox	1	0	0	1	0	2
Lagrange	0	0	0	0	0	1
Madison	0	0	0	0	0	1
Martin	0	0	0	0	0	1
Orange	0	0	0	0	1	0
Perry	2	0	2	0	1	4
Pike	0	0	0	0	0	3
Posey	3	100	1	0	0	6
Rush	1	0	1	0	0	0
Shelby	2	0	0	2	0	2
Spencer	1	0	0	1	0	2
Starke	0	0	0	0	0	1
Sullivan	2	0	1	1	0	5
Vanderburgh	1	10	0	0	0	2
Vigo	2	80	0	0	0	1
Wabash	1	0	1	0	0	0
Warrick	0	0	0	0	0	1
Total Oct.	20	190	8	7	1	43
Total Sept.	29	290	8	9	2	40
Difference	9	100	0	2	1	3

OHIO

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Ashland	1	0	0	1	0	4
Athens	10	2	6	3	3	10
Belmont	1	0	1	0	1	1
Columbiana	1	0	1	0	0	0
Coshocton	3	0	1	2	1	1
Cuyahoga	1	50	0	0	2	3
Delaware	0	0	0	0	0	1
Fairfield	2	0	1	1	0	1
Gallia	0	0	0	0	0	2
Guernsey	6	0	1	5	3	8
Hocking	1	5	0	0	1	1
Holmes	0	0	0	0	0	1
Huron	0	0	0	0	0	2
Knox	7	14	2	3	5	6
Lawrence	0	0	0	0	0	4
Licking	6	101	1	0	6	7
Lorain	2	0	2	0	1	2
Medina	3	12	2	0	1	3
Meigs	3	0	0	3	0	7
Monroe	1	0	0	1	0	2
Morgan	0	0	0	0	2	2
Muskingum	0	0	0	0	0	5
Noble	1	0	0	1	1	7
Perry	3	0	1	2	0	1
Richland	1	0	1	0	0	0
Scioto	1	0	0	1	0	0
Stark	2	0	1	1	0	10
Summit	0	0	0	0	0	1
Tuscarawas	3	0	0	3	0	2
Washington	13	31	4	5	6	10
Wayne	0	0	0	0	0	1
Total Oct.	72	215	25	32	33	105
Total Sept.	66	328	25	28	36	101
Difference	6	113	0	4	3	4

Lima Field

Summary of Field Operations

County—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Hancock	0	0	0	0	0	2
Putnam	1	45	0	0	1	1
Seneca	2	5	1	0	1	5
Wood	0	0	0	0	0	1
Total Oct.	3	50	1	0	2	9
Total Sept.	4	10	2	1	1	9
Difference	1	40	1	1	1	0

EASTERN FIELDS

Summary of Field Operations

Field—	Comp.	Prod.	Dry	Gas	Rgs.	Dlg.
Bradford	98	116	0	0	13	40
Allegany	52	34	0	0	5	18
Middle District	13	15	0	1	3	12
Butler-Armstrong	5	12	3	0	6	6
N. Y.-Pa. gas	5	0	3	2	3	22
S. W. Pa.	11	4	3	7	6	27
S. E. Ohio	22	90	7	7	7	33
W. Virginia	66	112	5	48	27	115
Ttl. Oct.	272	383	21	65	70	273
Ttl. Sept.	280	827	22	55	63	297
Difference	8	444	1	10	7	24

WILDCAT OPERATIONS

CALIFORNIA

IMPORTANT WELLS AND NORTHERN CALIFORNIA WILDCATS

Company, well, location and county—	S.T.R.	Depth	Status
Hancock-Bush, No. 4 Bradley, Santa Maria, S. Barbara	26-10-34	4,855	br. sh. drlg.
Cole, F. E., No. 18 Paderewski, S. Maria, S. Barbara	28-10-34	2,992	sd. sh. drlg.
Union Oil, No. 12 Coast, Santa Maria, Santa Barbara	26- 9-34	3,847	swabbing
O'Donnell, J. E., No. 1 Helen, Lompoc, S. Barbara	8- 7-33	4,976	sd. sh. drlg.
Richfield Oil, No. 1 Tinquaic, Foxen Can., S. Barbara	36- 9-32	1,073	sd. sh. drlg.
Barnsdall Oil, No. 1 Pezzoni, Gato Ridge, S. Barbara	15- 8-32	4,494	br. sh. drlg.
Continental Oil, No. 2 Laguna, Zaca Creek, S. Barbara	25- 8-31	4,270	sd. sh. drlg.
General Pet., No. 1 Laguna, Los Alamos, S. Barbara	6- 7-30	3,481	sd. sh. drlg.
Ventura Drlg., No. 1, Ojai, Ventura	10- 3-23	1,490	sd. sh. drlg.
High Mesa Oil, No. 1 Butcher, Ojai, Ventura	16- 4-22	1,801	sd. sh. drlg.
Claran Oil, No. 1 Hardison, Sespe, Ventura	22- 4-20	708	sd. sh. drlg.
Merchants Pet., No. 8 Hillside, Sespe, Ventura	1- 4-20	1,370	sd. sh. drlg.
St. Louis Oil, No. 1 Williamson, Sespe, Ventura	1- 4-20	1,256	sd. sh. drlg.
Section 20 Oil, No. 1, Sespe, Ventura	20- 5-19	2,300	rd. sd. drlg.
Texas Co., No. 135 Shiells, Shiells Canyon, Ventura	4- 3-19	4,066	C.P. 3,774
Ridge Oil, No. 1 Fox, Padre Canyon, Ventura	9- 3-24	7,303	idle
C. C. M. Oil, No. 7 Oakgrove, Padre Canyon, Ventura	23- 3-24	7,171	flow 140 b.d.
C. C. M. Oil, No. 6-A Hobson, Padre Canyon, Ventura	15- 3-24	.....	rigging up
C. C. M. Oil, No. 23-B Hobson, Rincon, Ventura	8- 3-24	4,092	flow 370 b.d.
Tide Water A., No. 36 V.L.W., Ventura Ave., Ventura	25- 3-23	6,440	sd. sh. drlg.
Tide Water A., No. 77 Lloyd, Ventura Ave., Ventura	27- 3-23	5,117	P.B. 4,960
Tide Water A., No. 81 Lloyd, Ventura Ave., Ventura	27- 3-23	7,600	will deepen
Tide Water A., No. 111 Lloyd, Ventura Ave., Ventura	27- 3-23	10,258	P.B. 5,925
Tide Water A., No. 126 Lloyd, Ventura Ave., Ventura	27- 3-23	6,860	hd. sh. drlg.
Tide Water A., No. 128 Lloyd, Ventura Ave., Ventura	27- 3-23	4,997	sd. sh. drlg.
Tide Water A., No. 7 Hartman, Ventura Ave., Ventura	22- 3-23	9,690	sd. sh. drlg.
Shell Oil, No. 96 Taylor, Ventura Ave., Ventura	28- 3-23	8,930	cleaning out
Shell Oil, No. 30 Edison, Ventura Ave., Ventura	20- 3-23	7,520	on gas lift
Shell Oil, No. 32 Edison, Ventura Ave., Ventura	21- 3-23	5,740	sd. sh. drlg.
General Pet., No. 16 Barnard, Ventura Ave., Ventura	21- 3-23	5,449	cleaning out
Lloyd Corp., No. 2 Dabney-Lloyd, Ventura, Ave., Vent.	23- 3-23	7,225	O. S. drlg.
Franco-Western Oil, No. 16, McKittrick, Kern	8-30-22	2,516	pump 330 b.d.
Cal. Lands, Inc., No. 1 Occidental, Lost Hills, Kern	24-26-20	7,343	dry; abd.
Tide Water A., No. 10-R Williamson, Lost Hills, Kern	2-26-20	1,478	cleaning out
Belridge Oil, No. 27-4, North Belridge, Kern	27-27-20	6,860	br. sh. drlg.
Belridge Oil, No. 27-19, North Belridge, Kern	27-27-20	8,185	O.S. drlg.
Belridge Oil, No. 27-31, North Belridge, Kern	27-27-20	8,184	O.S. drlg.
Belridge Oil, No. 26-25, North Belridge, Kern	26-27-20	.....	rigging up
Tide Water A., No. 22, North Belridge, Kern	21-27-20	7,582	hd. sh. drlg.
General Pet., No. 2 St. Helens, Belridge, Kern	12-28-20	1,118	sd. sh. drlg.
Shell Oil, No. 20 Freeman, Round Mountain, Kern	20-28-29	1,294	sd. sh. drlg.
Shell Oil, No. 1-15 Jewett, Round Mountain, Kern	29-28-29	1,770	pump 82 b.d.
Grizzly Bear Oil, No. 1 Kelly, Round Mountain, Kern	6-28-29	1,645	pump 225 b.d.
Fuhrman, A., No. 13 Kernco, Kern River, Kern	28-28-28	635	bailing
Helm & Smith, No. 10-A Kernco, Kern River, Kern	34-28-28	682	pump 17 b.d.
Hast Oil, No. 5 Kern, Kern River, Kern	34-28-28	360	O.S. drlg.
Reid, E. O., No. 1 Kern, Kern River, Kern	34-28-28	517	sd. sh. drlg.
Framac Oil, No. 3 Brown, Mount Poso, Kern	22-27-27	1,351	cleaning out
Richfield Oil, No. 1, Union Avenue, Kern	5-30-28	8,340	show. gas
Wood-Callahan Oil, No. 3 Comm., Edison, Kern	21-30-29	3,630	sd. sh. drlg.
O'Reily, F., No. 1 Berree, Edison, Kern	5-30-29	2,526	deepening
Texas Co., No. 1 Lowe, Fruitvale, Kern	7-29-27	10,122	fish D.P.
Greer, P. H., No. 2 Perrel, Mountain View, Kern	9-31-29	6,325	swabbing
Hogan Pet., No. 10 Wharton, Mountain View, Kern	32-30-29	4,983	flow 290 b.d.
Renner, G. E., No. 2 R.H.L., Sivert, Kern	27-30-30	2,047	hd. sd. drlg.
Continental Oil, No. 3-A, KCL, Wasco, Kern	8-27-24	13,644	P.B. 13,120
Continental Oil, No. 1, KCL, Seaboard, Wasco, Kern	26-27-24	13,064	will abd.
Standard Oil, No. 8-1-B, KCL, Wasco, Kern	17-27-24	13,564	sd. sh. drlg.
Standard Oil, No. 1 Mushrush, Wasco, Kern	7-27-24	13,139	form. test
Cal. Lands, Inc., No. 1 Salisbury, Buttonwillow, Kern	7-29-24	7,070	sd. sh. drlg.
Superior Oil, No. 3 Ruhl, Rio Bravo, Kern	1-29-25	10,650	sd. sh. drlg.
Superior Oil, No. 1 Geissinger, Rio Bravo, Kern	35-28-25	11,288	deepening
Superior Oil, No. 1 Wagner, Rio Bravo, Kern	35-28-25	11,480	flow 2,025 b.d.
Union Oil, No. 6-34, KCL, Rio Bravo, Kern	34-28-25	11,514	sd. sh. drlg.
Getty Oil, No. 3 Ramsey, Rio Bravo, Kern	35-28-25	10,825	sd. sh. drlg.
General Pet., No. 3 Wagoner, Rio Bravo, Kern	35-28-25	8,030	sd. sh. drlg.
General Pet., No. 4 Van Ness, Rio Bravo, Kern	2-29-25	10,530	sd. sh. drlg.
Shell Oil, No. 58-8-A, KCL, Famosa, Kern	8-27-26	7,492	sd. sh. drlg.
Standard Oil, No. 2 Fleishauer, Greeley, Kern	20-29-26	11,763	sd. sh. drlg.
Standard Oil, No. 11-16, KCL, Greeley, Kern	20-29-26	7,373	sd. sh. drlg.
Standard Oil, No. 1 Elrich, Greeley, Kern	20-29-26	9,050	sd. sh. drlg.
Continental Oil, No. 1-E, KCL, Stevens, Kern	17-30-26	8,574	redrlg. 8,187
Shell Oil, No. 47-20-B, KCL, Ten Section, Kern	20-30-26	8,211	flow 262 b.d.
Shell Oil, No. 72-29-A, KCL, Ten Section, Kern	29-30-26	4,993	sd. sh. drlg.
Shell Oil, No. 47-14-A, KCL, Canal, Kern	14-30-25	7,480	sd. sh. drlg.
Shell Oil, No. 87-4-B, KCL, Canal, Kern	4-30-25	9,231	sd. sh. drlg.
Ohio Oil, No. 9-E, KCL, Canal, Kern	14-30-25	8,033	sd. sh. drlg.
Standard Oil, No. 1 Bravo fee, Canal, Kern	12-30-25	7,864	redrlg. 4,740
Richfield Oil, No. 1, KCL, Tupman, Kern	32-30-25	8,523	looks good
Ohio Oil, No. 1-F, KCL, Coles Levee, Kern	10-31-25	9,365	looks good
Fried, Julius, No. 1 Fried, Midway-Sunset, Kern	34-32-24	4,704	gr. sd. drlg.
National Oil, No. 31, Midway, Midway-Sunset, Kern	35-32-23	620	sd. sh. drlg.
Richfield Oil, No. 1, KCL, Wheeler Ridge, Kern	28-11-20	7,950	sd. sh. drlg.
Petrol Corp., No. 33-5 Reserve, Tejon Ranch, Kern	33-11-19	6,976	may abd.
Tide Water A., No. 1-F, North Coalinga, Fresno	1-19-15	6,160	sd. sh. drlg.
Pet. Sec., No. 88-7-F, East Coalinga, Fresno	7-20-16	7,510	hd. sd. drlg.
Pet. Sec., No. 31-18-F, East Coalinga, Fresno	18-20-16	6,969	O.S. drlg.
Superior Oil, No. 2 fee, East Coalinga, Fresno	7-20-16	2,998	sd. sh. drlg.
Dauphin Dev., No. 2 Boone, Alcalde, Fresno	30-21-14	4,020	gr. sh. drlg.
Stuart Oil, No. 1 Alcalde, Alcalde, Fresno	12-21-14	718	sd. sh. drlg.
Union Oil, No. 4 King, Kettleman North, Fresno	29-21-17	8,520	redrlg. 7,650
Superior Oil, No. 4-H, Kettleman North, Fresno	29-21-17	8,525	completing
K.N.D.A., No. 27-8-Q, Kettleman North, Kings	6-22-18	8,710	cleaning out
K.N.D.A., No. 58-8-Q, Kettleman North, Kings	8-22-18	8,393	completing
K.N.D.A., No. 36-16-Q, Kettleman North, Kings	16-22-18	7,212	hd. sd. drlg.
K.N.D.A., No. 38-16-Q, Kettleman North, Kings	16-22-18	8,140	flow 7,492 b.d.
K.N.D.A., No. 65-20-Q, Kettleman North, Kings	20-22-18	6,665	br. sh. drlg.
K.N.D.A., No. 27-22-Q, Kettleman North, Kings	22-22-18	8,670	cleaning out
K.N.D.A., No. 36-22-Q, Kettleman North, Kings	22-22-18	.....	rigged up
Standard Oil, No. 46-13-H, Kettleman North, Kings	13-21-16	10,902	cleaning out
Standard Oil, No. 56-1-P, Kettleman North, Kings	1-22-17	1,397	sd. sh. drlg.
Standard Oil, No. 21-13-P, Kettleman North, Kings	13-22-17	10,940	sd. sh. drlg.
Standard Oil, No. 41-17-Q, Kettleman North, Kings	17-22-18	7,690	sd. sh. drlg.
Texas Co., No. 1 Lewis, King City, Monterey	13-19- 5	4,537	dry; abd.
Tannehill, L. B., No. 1 Reliz, King City, Monterey	36-20- 8	1,450	sd. sh. drlg.
Loma Grande Oil, No. 1 Edna, San Luis Obispo	28-31-13	1,770	may abd.
Epco, Inc., No. 1 Ajax, Union, San Luis Obispo	27-26-13	990	sd. sh. drlg.
Burch, I. L., No. 1 Little Cuyama, San Luis Obispo	4-10-26	1,480	dry; abd.
Shephard Oil, No. 3 Associates, Terra Bella, Tulare	35-22-27	870	sd. sh. drlg.
Ohio Oil, No. 2 Willard, Willows, Glenn	18-20 -2	2,253	dry; abd.
Amerada Pet., No. 1 California Lands, Colusa, Colusa	34-16- 1	8,060	br. sh. drlg.
Wilshire Oil, No. 2 Crowell, Half Moon Bay, S. Mateo	21- 6- 5	1,604	shut in
Richfield Oil, No. 1, Potrero Hills, Solano	10- 4- 1	5,234	P.B. 3,290
Superior Oil, No. 1 Reclamation, R. Vista, Sacramento	7- 3- 3	3,883	fl. 36,000 m.c.f.

IMPORTANT WELLS AND SOUTHERN CALIFORNIA WILDCATS

Company, well, location and county—	S.T.R.	Depth	Status
Mojave Pet., No. 1 Hillside, Gorman, Los Angeles	5- 8-18	477	sd. sh. drlg.
Texas Co., No. 1 Anderson, Ocean Park, Los Angeles	17- 2-15	5,270	sd. sh. drlg.
Rolling Hills Pet., No. 1 Weston, Palos Verdes, L. Ang.	27- 4-14	5,100	will test
Amron Oil, No. 1 Lomita, Torrance, Los Angeles	23- 4-14	4,870	sd. sh. drlg.
Colma Oil, No. 1 Smith, Torrance, Los Angeles	10- 4-14	4,882	sd. sh. drlg.
Douglas, A., No. 1 Beaudette, Torrance, L. Angeles	23- 4-14	4,950	pump 65 b.d.
Federated Oil, No. 1 Silver, Torrance, Los Angeles	23- 4-14	4,980	pump 170 b.d.
H. D. Oil, No. 1 Lomita, Torrance, Los Angeles	23- 4-14	3,807	rigged up
Kerben Oil, No. 2 Empire, Torrance, Los Angeles	23- 4-14	4,975	cleaning out
Kern Pet., No. 1 Madden, Torrance, Los Angeles	23- 4-14	3,796	will deepen
Mallon, Felix, No. 2 Martner, Torrance, Los Angeles	23- 4-14	2,990	sd. sh. drlg.
Medill, John, No. 4 Frenger, Torrance, Los Angeles	9- 4-14	3,595	rigged up
Moon Oil, No. 1 Beaver, Torrance, Los Angeles	23- 4-14	4,899	sd. sh. drlg.
Pettijohn, J. E., No. 1 Koala, Torrance, Los Angeles	22- 4-14	4,967	flow 350 b.d.
Russell, T., No. 2 Clarke, Torrance, Los Angeles	23- 4-14	3,785	cleaning out
Standard Oil, No. 1-1 Marble, Torrance, Los Angeles	15- 4-14	3,751	redrlg. 3,340
Standard Oil, No. 1-15 Marble, Torrance, L. Angeles	22- 4-14	4,980	flow 269 b.d.
Standard Oil, No. 2-9 Marble, Torrance, Los Angeles	22- 4-14	4,990	P.B. 4,950

KEY TO ABBREVIATIONS USED IN DRILLING REPORTS

Abd., abandoned.
Acd., acidized.
B.O., barrels of oil.
B.P.D., barrels per day.
B.D., barrels daily.
B.P., back pressure.
B.R., building rig.
Br. sh., brown shale.
B.S., basic sediment.
C.&P., cellar and pits
Cd. or Crd., cored.
C.D., corrected depth.
Cg., coring.
Cmtd., cemented.
C.O., cleaning out.
Comp., completed.
Compr., compressor.
C.P., casing pressure, also cement through perforations.
Csg., casing.
D.D., drilling (or drilled) deeper.
Drlg. or Drg., drilling.
Drk. or Dk., derrick.
D.S., drill stem.
D.&A., dry and abandoned.
Fsg., fishing.
Gbo., gumbo.
G.I., gas injection.
Gr., gravity.
Gr. sd., gray sand.
Grn. sh., green shale.
Hd. sd., hard sand.
H.F.W., hole full of water.
I.P., initial production.
L., lime.
L.D.D., later drilled deeper.
Lnr., liner.
Loc., location.
M.I.M., moving in material.
M.I.R., moving in rig.
M.I.R.T., moving in rotary tools.
M.O.T., milling on tools.
O.I.H., oil in hole.
O.S., oil sand.
O.T.D., old total depth.
O.W.D.D., old well drilling deeper.
O.W.P.B., old well plugging back.
P.B., plugging or plugged back.
P.B.P., pulling or pulled big pipe.
P.L., pipe line.
P.L.O., pipe line oil.
Pmpg., pumping.
P.O.P., putting on pump.
P.P., pulled pipe.
Rd. sd., red sand.
Rd. sh., red shale.
Recmt., recemented.
Rmg., reaming.
Redrlg., redrilling.
Rng., running.
R.O.G., rig on ground.
R.P., rock pressure.
R.U., rigging up.
R.U.R., rigging up rotary.
R.U.S.T., rigging up standard tools
R.&T., rods and tubing.
S. or Sd., sand.
S.D., shut down.
Sdy. sh., sandy shale.
Sdtr., or St., sidetracking.
S.D.P.L., shut down for pipe line
S.D.O., or S.D.W.O., shut down awaiting orders.
S.G., show gas.
Sh.&L., shale and lime.
S.I., shut in.
S.I.P., shut in, prorated.
S.L.M., steel line measurement.
S.O., show oil.
S.O.G.&W., show of oil, gas and water.
Spdg. or Spd., spudding.
S.R., straightreaming.
Stdg., standardizing (also standing)
S.W., salt water.
Swbg., swabbing.
T.A., temporarily abandoned.
Tbg., tubing.
T.D., total depth.
T.P., tubing pressure.
Tr., tract.
U.R., underreaming.
W.I.H., water in hole.
W.O., workover.
W.O.C. or W.O.C.S., waiting on cement to set.
W.P., working pressure.
W.S.O., water shutoff.
W.S.S.O.K., water shut off O.K.
W.S.R. or W.O.S.R., awaiting standard rig.
Wtr., water.

Standard Oil, No. 2-10 Marble, Torrance, L. Angeles	22-	4-14	4,835	sd. sh. drlg.
Standard Oil, No. 2-11 Marble, Torrance, L. Angeles	22-	4-14	2,070	sd. sh. drlg.
Star Pet., No. 1 Patton, Torrance, Los Angeles	23-	4-14	5,145	pump 75 b.d.
Westside Oil, No. 1 Exeter, Torrance, Los Angeles	23-	4-14	3,835	will deepen
West Basin Oil, No. 1 Eyster, Torrance, L. Angeles	23-	4-14	3,775	rigging up
C.C.M.O. Co., No. 15, Torrance, Los Angeles	14-	4-14	3,715	to deepen
C.C.M.O. Co., No. 18, Torrance, Los Angeles	14-	4-14	4,795	sd. sh. drlg.
Bush Oil, No 2 Gimenez, Harbor City, Los Angeles	25-	4-14	4,793	sd. sh. drlg.
B.&G. Oil, No. 52 Hawkins, Harbor City, L. Angeles	25-	4-14	5,231	flow 340 b.d.
Caminol Co., Ltd., No. 3-14 Lomita, H. City, L. Ang.	25-	4-14	5,103	sd. sh. drlg.
General Pet., No. 11 Poggi, Harbor City, Los Angeles	25-	4-14	2,876	sd. sh. drlg.
General Pet., No. 12 Poggi, Harbor City, L. Angeles	25-	4-14	2,994	sd. sh. drlg.
Macrate, A. N., No. 1-1 Kupfer, Harbor City, L. Angl.	25-	4-14	2,982	sd. sh. drlg.
Macrate, A. N., No. 1 Holden, Harbor City, L. Angl.	25-	4-14	4,850	sd. sh. drlg.
Padran Oil, No. 1 McEwen, Harbor City, Los Angeles	25-	4-14	5,304	cleaning out
Ring Oil, No. 4 Hawkins, Harbor City, Los Angeles	25-	4-14	5,250	flow 420 b.d.
Sunset Oil, No. 1 Security, Harbor City, Los Angeles	25-	4-14	5,300	sd. sh. drlg.
Sierra Trad., No. 1 Spring, Harbor City, L. Angeles	30-	4-13	5,180	pump 130 b.d.
West. Talc., No. 1 Pierce, Harbor City, Los Angeles	25-	4-14	5,325	cleaning out
Union Oil, No. 63 Callender, Dominguez, Los Angeles	32-	3-13	7,485	swabbing
Union Oil, No. 64 Callender, Dominguez, Los Angeles	33-	3-13	5,630	sd. sh. drlg.
Union Oil, No. 49 Hellman, Dominguez, Los Angeles	33-	3-13	7,700	sd. sh. drlg.
Shell Oil, No 95 Reyes, Dominguez, Los Angeles	33-	3-13	7,675	flow 619 b.d.
Richfield Oil, No. 1 Estate, Dominguez, Los Angeles	2-	4-13	1,994	sd. sh. drlg.
Fairfield, F. E., No. 1 Abel, Rosecrans, Los Angeles	19-	3-13	7,399	redrlg. 5,775
Bankline Oil, No. 1 Kirby, Rosecrans, Los Angeles	20-	3-13	7,655	redrlg. 5,860
Barnsdall Oil, No. 10 Rosecrans, Rosecrans, L. Angl.	20-	3-13	8,501	sd. sh. drlg.
Barnsdall Oil, No. 11 Rosecrans, Rosecrans, L. Angl.	20-	3-13	7,625	sd. sh. drlg.
Universal Cons'd., No. 6 Trust, Rosecrans, L. Angl.	18-	3-13	7,976	P.B. 7,577
Republic Pet., No. 1 Trust, Rosecrans, Los Angeles	18-	3-13	7,571	O.S. drlg.
Superior Oil, No. 12 Maxwell, Rosecrans, L. Angeles	19-	3-13	6,577	sd. sh. drlg.
Royalty Ser., No. 2 Gordon, Rosecrans, Los Angeles	19-	3-13	7,783	O.S. drlg.
West. Gulf Oil, No. 1 Bagg, Rosecrans, Los Angeles	17-	3-13	5,872	sd. sh. drlg.
Basin Oil, No. 2 Club, Potrero, Los Angeles	34-	2-14	6,154	sd. sh. drlg.
Barnsdall Oil, No. 4 R.S.F., Newhall, Los Angeles	26-	4-17	6,276	sd. sh. drlg.
Continental Oil, No. 1 R.S.F., Newhall, Los Angeles	20-	4-17	1,387	sd. sh. drlg.
Newhall Associates, No. 4 Needham, Newhall, L. Ang.	13-	3-16	3,504	milling 1,758
Mojave Pet., No. 2 Jennings, Newhall, Los Angeles	33-	5-14	200	sd. sh. drlg.
Royal Lands, No. 1 Ramona, Castaic, Los Angeles	8-	4-17	1,220	sd. sh. drlg.
General Pet., No. 28 Harbor, Wilmington, L. Angeles	2-	5-13	3,550	O.S. drlg.
General Pet., No. 29 Harbor, Wilmington, L. Angeles	2-	5-13	3,917	flow 360 b.d.
General Pet., No. 17 S. P., Wilmington, Los Angeles	2-	5-13	4,103	sd. sh. drlg.
Master Pet., No. 1 Chuck, Wilmington, Los Angeles	33-	4-13	3,442	redrlg. 3,020
Getty Oil, No. 4-W, Wilmington, Los Angeles	33-	4-13	3,594	redrlg. 2,985
Pacific West. Oil, No. 1 Comm., Wilmington, L. Angl.	33-	4-13	5,690	O.S. drlg.
Union Pacific R. R., No. 86, Wilmington, L. Angeles	3-	5-13	3,542	O.S. drlg.
Union Pacific R. R., No. 93, Wilmington, L. Angeles	4-	5-13	4,093	O.S. drlg.
Union Pacific R. R., No. 94, Wilmington, L. Angeles	4-	5-13	2,520	sd. sh. drlg.
Union Pacific R .R., No. 10-E, Wilmington, L. Angeles	3-	5-13	3,774	flow 501 b.d.
Union Pacific R. R., No. 2-EU, Wilmington, L. Angeles	34-	4-13	2,498	sd. sh. drlg.
Universal Cons'd., No. 3 Newport, Wilming., L. Angl.	2-	5-13	4,100	O.S. drlg.
St. Helens Pet., No. 29 Monterey, Montebello, L. Angl.	2-	2-12	6,380	sd. sh. drlg.
St. Helens Pet., No. 2 Taylor, Montebello, L. Angeles	2-	2-12	6,140	hd. sh. drlg.
Union Oil, No. 3 Howard, Montebello, Los Angeles	2-	2-12	5,465	swabbing
Herley-Kelly, Inc., No. 1 Masser, Montebello, L. Angl.	2-	2-12	6,550	deepening
Pongratz Pet., No. 1 Martin, Montebello, L. Angeles	2-	2-12	6,432	flow 825 b.d.
Standard Oil, No. 1 Kaufman, Montebello, L. Angeles	2-	2-12	6,465	flow 483 b.d.
Mont. Res. Oil, No. 1 M.L.&W., Montebello, L. Angeles	2-	2-12	6,214	sd. sh. drlg
Hathaway Oil, No. 1 Dore, Montebello, Los Angeles	11-	2-12	7,181	recmtd. 7,035
Caminol Co., Ltd., No. 2-10, N. Long Beach, L. Angl.	13-	4-13	6,597	sd. sh. drlg.
Johnston Drlg., No. 36, North Long Beach, L. Angeles	13-	4-13	2,797	sd. sh. drlg.
Massey & Asso., No. 1 Taylor, Long Beach, Los Angl.	19-	4-12	4,040	redrlg. 3,654
De Soto Oil, No. 1 Signal, Long Beach, Los Angeles	30-	4-12	9,750	sd. sh. drlg.
Brea Canyon Oil, No. 49 Brea, Brea Canyon, Orange	2-	3-10	1,496	hd. sd. drlg.
Shell Oil, No. 20 Orange, Brea Canyon, Orange	2-	3-10	4,900	sd. sh. drlg.
Battersby, J. M., No. 1 Associates, Carmenita, Orange	21-	3-11	8,498	gr. sh. drlg.
Graham-Loftus Oil, No. 2 Perkins, E. Coyote, Orange	13-	3-10	3,002	sd. sh. drlg.
Shell Oil, No. 1 Herriman, Richfield, Orange	22-	3- 9	2,351	sd. sh. drlg.
McKeon, John, No. 1 New Fields, Sun. Beach, Orange	16-	5-11	4,180	sd. sh. drlg.
J. E. F. Oil, No. 1 Bruce, Huntington Beach, Orange	36-	5-11	3,297	sd. sh. drlg.
Southwest Expl., No. 1 State, Hunt. Beach, Orange	10-	6-11	3,750	O.S. drlg.
Southwest Expl., No. 1 Harper, Hunt. Beach, Orange	10-	6-11	3,598	sd. sh. drlg.
Apex Pet., No. 1 Harper, Huntington Beach, Oragne	36-	5-11	4,430	sd. sh. drlg.
A. V. Oil, No. 1 Newport, Costa Mesa, Orange	16-	6-10	4,751	recmtd. 4,484
So. Counties Oil, No. 1 Serrano, San Bernardino	22-	2- 8	2,417	sd. sh. drlg.
Dauphin Dev., No. 1 Irwin, Ponto, San Diego	16-12-	4	618	sd. sh. drlg.

KANSAS

Week Ending November 12 (Descriptions are East unless marked otherwise)

Barton County

C. L. Carlock and Atlantic Ref. Co. No. 1 Demel, NE NW Sec. 30-17-13w. Fsg, 3,127 ft.

Long & Johnson No. 1 Eveleigh, SW SW NE Sec. 3-18-14w. Drlg. 3,050 ft.

I. W. Murfin No. 1 Birzer, NE SW Sec. 21-19-11w. S.D. 575 ft.

J. C. Shaffer, Inc., No. 1 Addie, SW NW Sec. 28-16-14w. Lansing 3,188 ft.; Arb. 3,441 ft.; S.S.O.; R.U.S.T. 3,450 ft.

Butler County

Soloman & Alexander No. 1 Sawyer, SW NW SW Sec. 2-28-7. S.D. 183 ft.

Stewart & Gross No. 1-A Semisch, NW SE SW Sec. 34-27-7. Drlg. 2,390 ft.

Cowley County

Ben Grabam et al No. 1-A Clark, NW NW NE Sec. 11-31-3e. Fsg. 3,192 ft.

Ben Grabam and Continental No. 1 Community, NW Sec. 23-32-5. Bart. sd. 2,992 ft.; Arb. 3,549-57 ft., T.D.; H.F.W.; P.B. 2,877 ft.; 5,000,000 ft. gas.

Dickinson County

Franks et al No. 1 Huffman, NW SW Sec. 11-13-1. Rng. 10-in. 1,177 ft.

Ellis County

Cities Service No. 2 Samuelson, C NE Sec. 36-11-17w. Arb. 3,412 ft.; T.D. 3,500 ft.; D.&A.

Grant County

Panhandle Eastern No. 1 Joyce, C SE Sec. 36-30-37w. T.D. 2,798 ft.; 3,500,000 ft. gas; comp.

Panhandle-Eastern No. 1 Parsons, C N½ SW Sec. 25-30-37w. W.O.C. 550 ft.

Panhandle-Eastern No. 1 Towler, C SE Sec. 20-30-37w. Drlg. 2,700 ft.

Greenwood County

J. Dunlap et al No. 1 Warren, NW NW SW Sec. 4-28-10. S.D. 2,155 ft.

Harvey County

Derby Oil and Gary Drlg. Co. No. 1 Jones, CEL NE NW Sec. 7-22-1w. Cmtd. csg. 3,289 ft.

Hannahan Drlg. No. 1 Lagree, SE SE Sec. 4-23-3w. T.D. 280 ft.; S.D.

Kingman County

Bunte Bros. No. 1 Shepard, SE SE SE Sec. 10-27-10w. T.D. 4,529 ft.; P.B. 4,086 ft.; pmp. 27 B.O. and 22 B.W. in 6 hrs.

McPherson County

Marylyn Oil No. 1 Dixon, NW NE NW Sec. 7-19-2w. Rng. csg. 2,770 ft.

Western Kans. O. & R. Co. No. 1 Union, NW NE SW Sec. 18-17-1w. T.D. 2,986 ft.; est. 80 B.O.P.D.

Marion County

Cox & McGinnis and Saco Oil Co. No. 1 Jolliffe, C S½ SW SE Sec. 2-22-5. T.D. 1,375 ft., S.D.

Johnson et al No. 1-A Miltz, SW SW SW Sec. 24-17-4. T.D. 2,275 ft.; S.D.

Mead County

Cragin, Reeuscher & Turner No. 1 Adams, NW NW SE Sec. 22-34-30w. T.D. 200 ft.; R.U.R.

Pacific Midwest Oil No. 1 Rexford, NE SE SW Sec. 8-30-29w. S.D. 1,435 ft.

Ness County

C. L. Carlock and J. C. Shaffer No. 1 Smith, C SW SE Sec. 11-17-25w. Drlg. 3,805 ft.

Ottawa County

Babcock Oil No. 1 Copeman, NW NW Sec. 18-10-2w. C.O. 2,675 ft.

Pottawatomie County

I. A. Turner No. 1 Unshide, C NE NW Sec. 32-8-9. H.F.W.; drlg. 1,690 ft.

Pratt County

Champlin Ref. Co. No. 1 Elliott, SW NE Sec. 26-27-14w. Fsg. 4,857 ft.

Reno County

H. B. Garden No. 1 Strickler, NW Sec. 17-22-6w. T.D. 4,035 ft.; S.D.

Rice County

Mac Oil Co. No. 1 Malone, SE SW NW Sec. 36-20-10w. U.R. 3,361 ft.

Spurrier & Bruce No. 1 Cary, NE NW NW Sec. 30-18-8w. O.W.D.D.; O.T.D. 1,530 ft.; S.D. 1,680 ft.

Rooks County

Phillips Pet. Co. No. 1 Tanzey, C NW SW Sec. 25-8-18w. Arb. 3,418-3,423 ft., T.D.; set. csg.

Producers No. 1 Ham (O.W.D.D.), SW NW Sec. 25-7-19w. O.T.D. 1,800 ft.; U.R. 2,237 ft.

Russell County

Phil-Han No. 1 Weimeister, SW Sec. 18-14-13w. Fsg. 1,510 ft.

W. I. Southern No. 1 Sellens, SW cor. Sec. 22-15-13w, Cd. 3,331 ft.

Western Kans. O. & R. No. 1 Schneider, NE NW Sec. 35-15-14w. S.O. 3,128-31 ft.; Arb. 3,346 ft.; T.D. 3,355 ft.; pmp. est. 7 B.O.P.H.

Yankey & Stearnes No. 1 Krog, NW SE NW Sec. 7-15-13w. T.D. 3,046 ft.; set csg.

Saline County

Central States Oil Co. No. 1 Crawford, NW SW NE Sec. 26-13-3w. Drlg. 1,100 ft.

Sedgwick County

D. M. Crowe No. 1 Murphy, SW SE Sec. 34-29-1w. S.O. at 3,500 ft.; drlg. 3,560 ft.

Frank Hudson et al No. 1 Fulton, NE SE Sec. 35-28-1e. U.R. 2,356 ft.

Stafford County

Stanolind O. & G. Co. No. 1 Curtis, SE cor. Sec. 31-21-12w. Viola 3,544 ft.; Arb. 3,638 ft.; R.U.S.T. 3,640 ft.

Sumner County

Cameron & Spencer No. 1 Frey, NW cor. Sec. 5-30-1e. Drlg. 1,910 ft.

Thomas County

Ramsey Pet. Co. and John Mabee No. 1 Ryan, C NE SE Sec. 27-8-32w. T.D. 4,980 ft.; fsg.

Wabaunsee County

Fowler & Tague et al No. 1 Aye, NW SW NW Sec. 10-12-8. S.D. 300 ft.

Woodson County

M. J. Trott No. 1 Abbott, NW NE NE Sec. 21-25-14e. Drlg. 1,325 ft.

OKLAHOMA

Week Ending November 12

NORTHERN OKLAHOMA

Caddo County

Texas Co. No. 1 Smith, C NE NW Sec. 2-5-12w. T.D. 2,556 ft.; S.D.O.

Cleveland County

Big Chief and Gulf No. 1 Stratiger, NW NW SW Sec. 25-9-2w. T.D. 7,179 ft.; P.B. & W.O.C.

Harper, Turner et al No. 1 Taylor, SE NE NW Sec. 23-8-2w. Rig.

Nels-Burrton No. 1 Hirsch, NW NW NE Sec. 17-9-2w. O.W.P.B.; O.T.D. 7,692 ft.; C.O. at 3,000 ft.

Garfield County

Champlin Ref. Co. No. 1 Boehm, SW SW NE Sec. 4-24-8w. Viola 6,595 ft.; Iolo. 6,625 ft.; 1st Wilcox 6,658 ft.; dry; 2nd Wilcox 6,690 ft.; F. 304 B.O. in 24 hrs., 10% wtr.

Garvin County

H. R. Hollenbach et al No. 1 Butterly, NE NE SE Sec. 22-1n-1e. 3,218,000 ft. gas; drlg. 3,205 ft.; S.D.; repairs.

Grady County

Carter Oil Co. et al No. 1 Smith C-58, C SE SW Sec. 26-5-8w. Drlg. sh. 5,020 ft.

Hughes County

City of Holdenville No. 1 Fairgrounds, SE SE SE Sec. 13-7-8. S.D. at 1,200 ft.

Homer Doup et al No. 1 Bond, NE NE SW Sec. 7-7-9. S.D. 3,098 ft. 639 ft.; est. 25,000,000 ft. gas; cmtg. 4,905-20 ft.

Phillips Pet. Co. No. 1 Mandler, SE SW SW Sec. 1-6-10. Drlg. 3,970 ft.

Jackson County

Lippert No. 1 Howard, NE SW NW Sec 10-3-19w. O.W.D.D. T.D. 1,510 ft.; S.D.

Kay County

Atlantic O. & R. Co. No. 1 Watson, SE SE NW Sec. 28-28-1w. Drlg. 3,633 ft.

Louis Blosser No. 1 Rudolph, NE NE SW Sec. 27-29-1w. Drlg. 3,577 ft.

Crawford No. 1 Boehl, SE SE NW Sec. 34-27-2w. Drlg. 610 ft.

E. W. Hamilton No. 1 Riddle, NW cor. Sec. 3-26-4. Drlg. 2,300 ft.

Gus Little No. 1 Prunty, NE NE SW Sec. 33-28-3. Drlg. 205 ft.

Tide Water Oil Co. No. 1 Hockman, NW NW NE Sec. 19-28-1. Wlx. 3,288 ft.; Arb. 3,421 ft.; P.B. to 3,330 ft. to test.

Kingfisher County

Burton Pet. Corp. No. 1 Zerger, C SE SW Sec. 5-18-6w. S.D. at 3,510 ft.; lost cones.

Kiowa County

Crawford & Zelliff No. 1 Kimray, SW SW NW Sec. 36-5-18w. S.D. 354 ft.

R. L. Emerson No. 1 Handcock, SE SE NE Sec. 26-6-15w. Drlg. 460 ft.

Hughes & Reese No. 1 Fultz, SE SE SE Sec. 10-6-18w. T.D. 1,238 ft.; W.O.C.

Lincoln County

Summit Drlg. Co. No. 1 Gordon, NE NE NE Sec. 27-17-2. Cg. 4,816-4,835 ft.; S.O. and preparing to test.

Noble County

H. R. Hollenbach No. 1 Mathews, C SW NW Sec. 9-20-1. T.D. 5,050 ft.; S.D.

Phillips Pet. Co. No. 1-A Robertson, NW NE SW Sec. 29-24-1w. Drlg. 2,990 ft.

Okfuskee County

Lease Inv. Co. No. 1 fee, SE SW SE Sec. 21-13-10. Drlg. 2,942 ft.

Okmulgee County

Jim Wise Drlg. Co. No. 1 Morrow, SW NW NE Sec. 16-15-13. S.D.; wtr. 150 ft.

Pawnee County

Ed Kelly No. 1 Hill, SW SW SE Sec. 1-21-5. Drlg. 865 ft.

Payne County

Continental Oil Co. No. 1 Donahoe, NW SW Sec. 16-18-2w. Cg. 5,893-5,896 ft.; S.S.O.; drlg. ahead.

Pittsburg County

J. Campbell No. 1 Featherstone, C N½ NW SW Sec. 19-3-12. S.D. 300 ft.

Supreme Oil Corp. No. 1 Hickey, NW SW NW Sec. 4-2-15. T.D. 1,040 ft.; S.D.

Supreme Oil Corp. No. 1 Stevenson, SW SW SE Sec. 27-3-14. T.D. 1,300 ft.; M.I. rotary.

Pontotoc County

Jack Lynch et al No. 1-A Parker, SW SW SE Sec. 17-4-8. T.D. 4,572 ft.; P.B. 4,490 ft.; rip in csg.; P.B. 4,090 ft.; S.D.

H. Z. Moore No. 1 Payne, SE NW SE Sec. 16-4-4. T.D. 997 ft.; S.S.O.; S.D.

Union Dev. Co. No. 1-A Abbott, SW NW NE Sec. 34-3-6. T.D. 2,620 ft.; S.D.

Pottawatomie County

Hall & Briscoe No. 1 Merkle, NW NW SE Sec. 32-8-5. 1st Wlx. 4,385 ft.; 2nd 4,460 ft.; T.D. 4,476 ft.; P.B. 4,386 ft.; shot and C.O.

Seminole County

Lesslie Rogers No. 1 Kidd, NE SW SE Sec. 33-10-8. T.D. 200 ft.; S.D.

Simpson-Roodhouse No. 1 Watson, SE NE SW Sec. 11-6-5. Drlg. 1,455 ft.

J. F. Smith No. 1 Wolfe, NE NE SW Sec. 36-7-5. T.D. 2,987 ft.; shot and P.O.P.; est. 60 B.O.P.D.

Texas County

Republic Nat. Gas Co. No. 1 Judd, CSL SW Sec. 24-6n-15ecm. T.D. 2,870 ft.; gas 7,100,000 ft.

Washita County

Continental Oil Co. No. 1 Proctor, C NW Sec. 28-10-20w. Drlg. 9,294 ft.

L. B. McWhirter No. 1 fee, NW SW SW Sec. 34-8-19w. Drlg. 2,184 ft.

SOUTHERN OKLAHOMA

Carter County

Pure Oil Co. No. 1 Noble, NE SE Sec. 35-3s-1e. Drlg. 1,597 ft.

Choctaw County

Clyde Ross et al No. 1 Hardy, SE SE NW Sec. 21-7s-15. Drlg. sdy. L. 1,300 ft.

Tillman County

Smith No. 2 Hammel, NE NW NW Sec. 6-5s-15w. T.D. 2,380 ft.; recvd. D.P. and S.D.

ARKANSAS

Calhoun County

Samuel S. Alexander No. 1 Smythe, C NE NE Sec. 7-11-14. S.D. hd. sd. 3,085 ft.

C. E. Murdock No. 1 Southern Kraft Corp., SE cor. NW NW sec. 17-14-13 Top Nac. 2,372 ft.; top Tokio 2,920 ft. S.D. 3,110 ft.

Columbia County

Atlantic Ref. Co. No. 1 Garrett, C NW SW Sec. 13-17-20. Cd. T.L. 7,519 ft.; D.S.T. 2,800 ft.; oil; 200 ft. brksh. wtr. top por. L. 7,548 ft.; D.S.T. 7,604-22 ft.; ¼-in. bttm. ck.; 35 lbs. W.P. 11 min.; set 7-in. csg.; T.D. 7,627 ft.

Pet. Finance Co. No. 1 Barnett, C NW SE Sec. 14-17-20. R.U.

Pet. Finance Co. No. 1 Garrett, C SW SW Sec. 13-17-20. M.I. rig.

Sam M. Richardson et al No. 1 B. Francis et al, NW cor. NW SW Sec. 7-17-13. R.U.

Standard Oil Co. of La. No. 1 E. D. Harris, NW cor. NW SE Sec. 15-7-19. Drlg. brkn. sd.&sh. 6,247 ft.

Standard Oil Co. of La. No. 4 McKean, SW cor. NW SW Sec. 8-16-22. Set 9⅝-in. csg. 2,063 ft.; drlg. sh. 4,577 ft.

Standard Oil Co. of La. No. 1 Minnie Harris, NE cor. NE SW Sec. 15-17-19. Drk.

Tide Water Seaboard No. 1 Beene, C SE NW Sec. 15-18-19. Top Cotton Valley 5,887 ft.; cd. 7,000-08 ft.; rec. 4 ft. sd. &sh.; stain oil; cd. 7,020-32 ft.; rec. 1 ft. wtr. sd. and 6 jts. gr. sd.&sh.; no show; drlg. 7,048 ft.

G. H. Vaughn No. 2 Garrett, C SE SE Sec. 14-17-20. D.S.T. 5,733-58 ft.; 15 min.; ¼-in. cks.; rec. 1,000 ft. drlg. fluid and show cut oil; W.P. 26 lbs.; top Bod. 7,259 ft.; top Smkovr. L. 7,318 ft.; top por. L. 7,346 ft.; D.S.T. 7,363-83 ft.; 6 min.; ¼-in. cks.; made 250 lbs. gas press.; 125 ft. drlg. fluid, 10 ft. 56.9-grav. oil; cd. L. 7,383-7,443 ft.; D.S.T. 7,403-23 ft.; ¼-in. cks. rec. 100 ft. drlg. fluid and stain dist.; 240 lbs. wet gas in 6 min.; por. L. sat. 7,483-7,502 ft.; T.D. 7,522 ft.; comp.; 425 B.P.D.; ¼-in. ck.; T.P. 1,400 lbs.; C.P. 1,500 lbs.

Little River County

Barbee et al No. 1 Ada Mills, SE cor. SW NW Sec. 18-12-29. R.U.

C. & M. Drlg. Co. No. 1 Strawn, SW cor. SE Sec. 20-10-32. 10-in. csg. 63 ft.

Harford Oil Corp. No. 1 Pinning, C NE NE SW Sec. 6-13-30. S.D. 1,727 ft.

Herzer & Smith No. 1 Waldrop, SE cor. NW Sec. 4-13-31. Top anhy. 2,403 ft.; b. anhy. 2,470 ft.; cd. sd.; no show 2,707-19 ft. and S.W. sd. 2,719-24 ft.; D.S.T. 3,148-66 ft.; rec. 22 ft. drlg. mud; no show; T.D. 3,431 ft.; S.D.

Joe G. Straham et al No. 2 Dierks Lbr. Co. Top L. 2,425 ft.; wshg. to bttm. 3,354 ft.

Lonoke County

Cabot Drlg. Club, Inc., No. 1 Benson Townsite, Sec. 18-4n-9w. Set 4½-in. csg. on pkr. 1,540 ft.; S.D. 2,406 ft.

J. W. Eddington No. 1 Anderson. S.D. 900 ft.

Miller County—Rodessa

Gulf Ref. Co. No. 5 Johnson, SW cor. Sec. 29-15-15. R.U.

F. W. Martin & Co. No. 1 Watts, SE cor. SW NE Sec. 2-20-26. Top anhy. 5,410 ft.; T.M.A. 5,675 ft.; top Hill 6,046 ft.; top Gloyd 6,176 ft.; por. L. 6,222-50 ft.; ran 5-in. csg.; T.D. 6,252 ft.; flwd. 300 B.O. and 75 B. S.W. in 17 hrs.; ½-in. ck.; T.P. 125 lbs.; C.P. 1,250 lbs.; 5-in. csg. 6,219 ft.; P.B. 6,210 ft. to cut off S.W.

Mrs. S. O. Thompson No. 1 Gen. Am. Life Ins. Co., SE cor. SE SW Sec. 20-14-26. Drlg. anhy. 3,266 ft.

Mississippi County

Benedum & Trees Oil Co. No. 1 Mack, 330 ft. SW cor. NW SW Sec. 2-15n-12e. Top Nac. 2,160 ft.; set 7-in. csg 2,897 ft.; drlg. sdy. sh. 3,076 ft.

Nevada County

Texas Canadian Oil Corp. No. 2 Stocks, NW SW SE Sec. 9-15-22. Cor. T.D. 1,395 ft.; 7-in. 1,340 ft.; perf. csg. 1,395 ft.; recmtd. csg. and ripped csg. 1,209-15 ft.; W.O.S.R.; 250 ft. O.I.H.; T. Nac. 1,202 ft.

O. F. Whittaker No. 1 Edwards, Sec. 3-15-20. Cd. brkn. sd.; S.O. 2,030-2,155 ft. set 6¼-in. csg. 2,030 ft.; W.O.S.R.; 60 ft. F.I.H. 2,155 ft.

Ouachita County

Gulf Ref. Co. No. 5 Johnson, SW cor SE SW Sec. 29-15-15. 6⅝-in. csg. 1,973 ft.; drld. out to 2,030 ft.; pmpg. est. 600 B.P.D. S.W.; slight rainbow oil; T.D. 1,983 ft.

Pike County

Bruce Wallace No. 1 Tilyeu, NE cor. SE Sec. 26-8s-24w. S.D.; W.O. 392 ft.

Pulaski County

A. L. Kitselman No. 2 A. L. Kitselman, Jr., SE SE SW Sec. 2-1s-13e. S.D. 3,752 ft.

Union County—Schuler

Delta Drlg. Co. No. 1 Powledge, SW cor. NW NW Sec. 21-18-17. Top Jones sd. 7,599 ft.; cd. to 7,651 ft. and drld. to 7,686 ft., T.D.

Fohs Oil Co. No. 1 Craig, C SE NE Sec. 5-18-14. Top Nac. 2,203 ft.; D.S.T. 2 min.; ⅜-in. cks.; rec. 40 ft. drlg. fluid; set 10¾-in. csg. 2,378 ft.; cd. top Tr. Pk. 3,068 ft.; top Crain sd. 3,158 ft.; drlg. coarse-grained S.W. sd. 4,530 ft.

E. M. Jones No. 2-B Murphy Ld. Co., SW cor. S½ NE NE Sec. 13-18-18 Top Jones sd. 7,507 ft.; cd. L. 7,627-86 ft.; drld. to 7,700 ft. and ran survey; 7-in. 7,675 ft.; comp.; 4,320 B.P.D.; ½-in. ck.; T.P. 25 lbs.; C.P. 425 lbs.; perf. 7,538-69 ft.; T.D. 7,700 ft.

E. M. Jones No. 3-B Murphy Ld. Co., SW cor. SE NE Sec. 13-18-18. R.U.

Lion Oil Ref. Co. No. 1 Banks, NW cor SW SE Sec. 12-18-18. Set 10¾-in. csg. 1,920 ft.; drlg. rd.&gr. sh. 5,668 ft.

Lion Oil Ref. Co. No. 1 Cecil, SE cor., Lot 6, NW Sec. 7-18-17. 16-in. 125 ft.; drlg. rd.&gr. sh. 4,310 ft.

Lion Oil Ref. Co. No. 3 Dee, SW NW Sec. 17-18-17. Set 10¾-in. csg. 1,884 ft.; drlg. rd. sdy. sh. 6,131 ft.

Lion Oil Ref. Co. No. 8 Hardy Murphy, C NE NW Sec. 9-16-15. Set 7-in. csg. 2,443 ft.; top Graves sd. 2,392 ft.; perf. 2,390-93 ft.; perf. 2,320-30 ft.; comp.; 65 B.P.D. oil and est. 30 B.P.D. S.W. on pmp.; T.D. 2,443 ft.

Lion Oil Ref. Co. No. 9 Hardy-Murphy, NW cor. NE NW Sec. 9-16-15. R.U.

Lion Oil Ref. Co. No. 7-B Hays, O.W. W.O., Sec. 3-16-15. Formerly comp. 2,121-24 ft.; T.D. 2,325 ft.; fsg. csg.

Lion Oil Ref. Co. No. 5 Marcus, Sec. 18-18-17. Top Jones 7,511 ft.; cd. top L. 7,607 ft.; T.D. 7,725 ft.; D.S. stk. 7,713 ft.; fsg. for 3,500 ft. D.S. after backing off 4,200 ft.

Lion Oil Ref. Co. No. 6 Marine, NW cor. SW NW Sec. 18-17-17. Drlg. rd. sdy. sh. 6,354 ft.

Lion Oil Ref. Co. No. 7 Mayfield, C Lot 2, NW Sec. 18-18-17. Set 10¾-in. csg. 1,932 ft.

Lion Oil Ref. Co. No. 7-A Morgan, C S½ Lot 7, SW Sec. 18-18-17. Top Jones sd. 7,539 ft.; top L. 7,644 ft.; cg. 7,652 ft.

Lion Oil Ref. Co. No. 3 Nelson, C S½, Lot 6, SW Sec. 18-18-17. Fsg. for rk. bit 7,413 ft.

Lion Oil Ref. Co. No. 4 Nelson, SW cor. Lot 5, SW Sec. 18-18-17. 10¾-in. csg. 1,940 ft.; recond. mud 4,770 ft.

Marine Oil Co. No. 3 Calloway, SE cor. S½ Lot 4, NW Sec. 18-18-17. Drlg. rd. &gr. sh. 4,134 ft.

C. H. Murphy No. 1 fee, SE cor. SW NE Sec. 13-18-18. Drlg. rd.&gr. sh. 6,290 ft.

Phillips Pet. Co. No. 1 Edwards, SW NE Sec. 17-18-17. 7-in. csg. 7,704 ft.; perf. 7,628-35 ft.; would not flow and reperf. 7,626-35 ft.; T.D. 7,740 ft.; reperf. 7,624-35 ft.; swbd. dry; S.D.; W.O.

Phillips Pet. Co. No. 1 Murphy, Lot 2 NW Sec. 19-18-17. Top Jones sd. 7,570 ft.; T.D. 7,735 ft.; 7-in. csg. 7,712 ft.; perf. 7,590-7,614 ft.; comp.; 1,124 B. P.D.; ½-in. ck.; T.P. 250 lbs.; C.P. 375 lbs.

Phillips Pet. Co. No. 1 Nelson, Lot 3 NW Sec. 19-18-17. Top Jones sd. 7,582 ft.; T.D. 7,735 ft.; 7-in. csg. 7,705 ft. comp.; 846 B.P.D.; ½-in. ck.; perf. 7,595-7,630 ft.; T.P. 300 lbs.; C.P. 600 lbs.

Phillips Pet. Co. No. 5 Sewell, NW cor. Lot 5, SW Sec. 7-18-17. Top Jones sd. 7,553 ft.; oolitic L. 7,657-7,706 ft.; drld. to T.D. 7,800 ft.

Union County—Other

E. G. Bradham No. 1 Raulston, C Sec. 12-17-14. Cd. 2,980-90 ft.; sdy. sh.; S.O.; cd. 2,996-3,003 ft.; no rec.; cd. 3,003-05 ft.; rec. 6-in. por. sat. sd.; D.S.T. 2,971-99 ft.; 13 min.; ¼-in. bottm. ck.; 125 lbs. W.P.; flwd. 7 min.; will set csg.; T.D. 3,005 ft.

J. H. Lockhart No. 4 Raulston, 330 ft. SW cor. NE SE Sec. 12-17-14. Drlg. 1,940 ft.

Ohio Oil Co. No. 5 Furlough, 330 ft. N, 990 ft. E, C Sec. 12-17-14. 8⅝-in. csg. 193 ft.; top gas sd. 2,966 ft.; T. sat. sd. 2,981-95 ft.; T.D. 3,010 ft.; comp.; 420 B.P.D.; ⅜-in. ck.; T.P. 300 lbs.; C.P. 515 lbs. and est. 400,000 ft. gas; perf. 5½-in. csg. 2,981-94 ft.

Snuggs, Sebersky & Bylick No. 1 Laney, C NE NE Sec. 28-17-14. Drlg. shk. 2,147 ft.

LOUISIANA

N. LOUISIANA WILDCATS

Bienville Parish

Ark.-La. Gas Co. No. 1-B Davis Bros. Lbr. Co., NW SW Sec. 7-16-4. 9⅝-in. csg. 2,557 ft.; D.S.T. 5,845-76 ft.; 50,000,000 ft. gas; open flow; 10 min.; ¼-in. cks. T.&B.; B.M.A. 5,640 ft.; b. stringer anhy. 5,753 ft.; D.S.T. 6,185-6,203 ft.; tstd. 1,530 ft. S.W. 16 min.; ¼-in. cks. T.&B.; top Pettit L. 6,706 ft.; no por.; drlg. sh. 6,764 ft.

Producers O. & G. Co. No. 1 Graves & Thomas, SE cor. SW SE Sec. 23-15-10. Set 13⅜-in. 180 ft.

Bossier Parish

W. M. Chambers No. 1 Thomas. SE cor. Sec. 10-22-11. S.D.; W.O. 2,780 ft.

H. M. Harrell et al No. 1 Edwards Est. Unit, Sec. 5-17-11. Drlg. sh. 1,200 ft.

Premier Inv. Co. No. 1 McDade, SE SW NE Sec. 28-19-11. T.D. 2,384 ft.; acd. with 1,000 gal.; csg. seat gave away; hole full S.W.

Premier Inv. Co. No. 46 Wyche, SW cor. N½ NW¼ Sec. 14-19-11. 8¼-in. 81 ft.; T.D. 320 ft.; comp.; 15 B.P.D.; top sd. 269 ft.; 6⅝-in. csg. 270 ft.

J. B. Stovall et al No. 3 Ark. Fuel Oil Co. fee, NE SE Sec. 15-19-11. 6-in. csg. 362 ft.; W.O.C.

Caddo Parish

C. L. Ablinger No. 1 Gregory, NE cor. Sec. 3-20-11. 6-in. 960 ft.; tstg. 971 ft.

Ark.-La. Gas Co. No. 1 Webb, C NW SW Sec. 4-16-13. 9⅝-in. csg. 1,236 ft.; drlg. chk. rk. 1,639 ft.

R. L. Bauman No. 1 Slattery Est., 660 ft. NW cor. Sec. 35-18-14. Set 13⅜-in. csg. 300 ft.; set 9⅝-in. csg. 2,053 ft.; top Pettit L. 5,541 ft.; top 5 ft. S.G.; next 14 ft. fairly good oil sat.; bal. to 5,575 ft. tight, odor O.&G.; T.D. 5,604 ft.; set 5½-in. csg. 5,602 ft.; porous L. 5,538-57 ft.; perf. 5,548-54 ft.; comp.; 10 B.P.H. oil on 23/32-in. ck.; T.P. 700 lbs.; C.P. 1,450 lbs.; est. 8,000,000 ft. gas.

F. W. Burford No. 1 Williams, SW cor. NW SW Sec. 4-23-15. Set 5½-in. csg. 6,052 ft.; T.D. 6,090 ft.

Carney et al No. 2 Hart; O.W.W.O. Old T.D. 2,372 ft.; C.O. and arng. set 6-in. csg. 1,495 ft.; comp.; pmpg. 10 B. P.D. and 400 B.P.D. S.W.; T.D. 1,800 ft.

W. D. Chew No. 4 Stiles, SE cor. NW Sec. 33-21-16. W.O.S.R. 1,870 ft.; 7-in. csg. set 1,856 ft.; comp.; 60 B.P.D.; pmpg.

W. D. Chew No. 6 Stiles, SW NE Sec. 28-21-16. Set 6-in. csg. 1,945 ft.; T.D. 1,954 ft.; tstd. S.W. 1,954 ft. and P.B. 1,944 ft.; drld. out to 1,954 ft.; tstd. S.W.; W.O. 1,954 ft.

Colonial Corp. No. 1 Thigpen-Herold, 330 ft. S and W, C Sec. 34-22-16. Drlg. ch. rk. 2,250 ft.

Paul Cooper No. 2 Stiles, SW SE Sec. 28-21-16. Setting csg. 1,542 ft.

L. L. Davidson No. 4 Muslow, SE cor. NW SE Sec. 26-21-16. Set 8-in. csg. 982 ft.

J. P. Driscoll et al No. 1 Woolworth, SE cor. Sec. 26-20-15. R.U.

Hollywood Oil Corp. No. 1 C.&B. Realty Co., C NE NE Sec. 22-17-14. B. ch. rk. 1,745 ft.; top anhy. 4,165 ft.; top Pettit sd. 5,674 ft.; no por.; top Tr. Pk. 5,957 ft.; T.D. no por. 6,009 ft.; P.B. 4,945 ft.; set 6⅝-in. csg. 4,975 ft.; perf. csg. 4,954-65 ft.; tstd. S.W. in ads. from 4,820-4,965 ft.; D.&A.; T.D. 6,009 ft.

W. C. Knox No. 1 Burton, NW cor. Sec. 7-20-15. 6⅝-in. csg. 1,339 ft.; T.D. 1,575 ft.; comp.; 50 B.P.D. through tbg.

Ben Levy No. 1 Crystal fee, SW cor. Sec. 25-21-16. 8-in. csg. 970 ft.; comp.; 2,000,000 ft. gas; T.D. 978 ft.

C. D. Loe No. 1 Meyer, SE cor. Sec. 33-18-14. Top Pettit 5,592 ft.; T.D. 5,628 ft.

McClanahan et al No. 1 Muslow, NE NW Sec. 31-21-15. Abd. 40 ft.; will not drill.

Manziel et al No. 3 Ramsey, NE SE Sec. 32-21-15. Set 5¼-in. csg. 1,348 ft.; acd. with 2,000 gal. at 1,590 ft.; W.O.S.R.

J. Ober & Sons No. 1 fee, SE cor. Sec. 36-21-16. Set 8-in. csg. 1,431 ft.; tr. dry 1,684 ft.; set 6-in. csg. 2,257 ft.; tstd. small spray O.&G.; csg. collapsed; T.D. 2,279 ft.; S.I.; hole cleaned; 1,700 ft. O.I.H.; W.O.S.R.

Rodessa O. & R. Co. No. 1 Chandler, C SW NE Sec. 34-18-14. Set 9⅝-in. csg. 2,067 ft.; D.S.T. 2,420-34 ft.; tstd. est. 5,000,000 ft. gas, 9 min.; ⅜-in. cks. T.&B.; rec. 270 ft. S.W.; drlg. L.&sh. 5,050 ft.

Harry Smith No. 1 Sproull, SE cor. Sec. 32-20-16. 5-in. csg. 1,411 ft.; tstg. 1,698 ft.

Southern Star Pet. Corp. No. 1 Muslow, SE NW Sec. 17-20-15. Pmpd. S.W.; arng. dpn. 1,860 ft.; S.D. 2,150 ft.

Tri-State Prod. Corp. No. 1 Stiles, SE cor. NE Sec. 28-21-16. Rng. csg. 1,850 ft.

Nat Wissman No. 1-A Stiles, NW NW Sec. 6-20-15. Set 7-in. csg. 1,040 ft.; T. D. 1,043 ft.; comp.; pmpg. 30 B.P.D. oil and 100 B.P.D. S.W.

Catahoula Parish

Sibley Sabine Oil Co. No. 1 Peck, S½ Sec. 36-10-8e. Drlg. sd.&sh. 2,200 ft.

Claiborne Parish

Magnolia Pet. Co. No. 1-B Patton, C NE NW Sec. 13-20-5. Por. L. 5,390-92 ft. and 5,397-5,405 ft.; cmtd. 7-in. csg. 5,388 ft.; T.D. 5,407 ft.; acdzg.

Maritzky & Bibby No. 1 McClung, Sec. 29-21-7. 6-in. csg. 1,819 ft.; T.D. 1,822 ft.; big. to tst.

E. T. Oakes et al No. 2 Kilgore, C NW SE Sec. 28-21-5. Hd. to slightly por. L. 5,294-5,303 ft.; 5½-in. csg. 5,287 ft.; used 6,000 gal. acd.; swbg. to test; tstd. S.S.O. 5,324 ft.; split csg. 2,600 ft.; cmtd. csg.; W.O.C. 5,324 ft.

De Soto Parish

S. S. Alexander No. 1-A Stoll, sec. 8 12-16. Set 7-in. csg. 2,705 ft.; acd. with 3,000 gal. and tstd. est. 2,000,000 ft. gas; 400 lbs.; gas exhausted; W.O.S.R.; 1,000 ft. O.I.H., 2,761 ft.

Paul Miller No. 2 Jal Drlg. Co., NE Sec. 5-11-11. Set 7-in. csg. 4,038 ft.; will perf. csg.; T.D. 4,205 ft.

Tippett Oil Corp. No. 1 Williams, SE cor. Sec. 31-13-11. Drlg. sh. 750 ft.

Grant Parish

Long & Porter No. 1 Swope, SE cor. NW SE Sec. 18-9-1e. 10-in. csg. 84 ft.; drlg. sh. 1,200 ft.

Fred Stovall No. 1 Mattheson, NW cor. Sec. 15-9-1e. 6-in. 1,527 ft.; T.D. 1,542 ft.; S.W.; D.&A.

La Salle Parish

Trichell et al No. 1 Gallagher, NW cor. Sec. 31-9-2e. Drlg. sh. 921 ft.

Madison Parish

Continental Oil Co. No. 2 Singer Mfg. Co., C Sec. 2-15n-11e. Set 7⅝-in. csg. 522 ft.; drlg. sh. 1,550 ft.

Red River Parish

N. W. Hunter No. 1 LeLong, NW cor. NW SE Sec. 33-12-10. 10-in. csg. 40 ft.; S.D.; 1,000 ft.; rig repair.

Magnolia Pet. Co. No. 59 Pugh, Sec. 12-12-11. Drlg. anhy.&sh. 5,004 ft.

J. C. Prine No. 3 Haynes, SW cor. Sec. 20-13-10. 5¾-in. csg. 2,510 ft.; D.D. to 2,560 ft.; W.O.S.R.

Sabine Parish

Addison & Peterson No. 1 Dew, SE cor. SW SE Sec. 22-8-11. Used 1,500 gal. acd. and tstd. S.O. 2,587 ft.; S.D. 2,589 ft.

Clyde Creighton No. 1 Bowman Hicks, C NE NW Sec. 3-7-12. Partly R.U. and S.D.

Earl F. Fox No. 1 Cook Ld. Co., SW cor. SE NW Sec. 1-9-12; O.W.W.O. O.T.D. 3,655 ft.; arng. dpn. 3,655 ft.

A. B. House No. 1 Sabine, NW NW Sec. 23-7-14. 8-in. csg. 2,134 ft.; used 7,000 gal. acd.; tstd. dry; W.O. 2,684 ft.

M. J. Kissick No. 1 J. Newton, NE cor. SE Sec. 1-7-11. Set 10-in. csg. 65 ft.; drlg. sh. 950 ft.

LeGrande & Brown No. 1 Tatum, NE cor. NW NE Sec. 17-8-13. Tstd. dry 2,130 ft.; tstd. S.G.; acd. with 1,000 gal.; tstd. dry 2,340 ft.; did not acd.; tstd. S.W.; S.O. 2,340 ft.; 500 ft. O.I.H.; will acd. 2,340 ft.

Morris Co. No. 1-A Ervine & Bishop, C NE SW Sec. 14-7-13. Set 6-in. csg. 2,177 ft.; used. 3,000 gal. acd.; tstg. 2,573 ft.

H. L. Nutting No. 1 Williams, SW cor. Sec. 13-7-11. Drlg. 2,600 ft.

C. R. Schuster No. 1 Mary Garcia, NE cor. NW SE Sec. 15-7-13. T.D. 2,603 ft. P.B. 2,585 ft.; tstd. dry S.D.; W.O. 2,585 ft.

Sklar & Neighbors No. 1 Martinez, Sec. 11-7-13. 6-in. csg. 2,172 ft.; used 3,000 gal. acd.; tstd. S.O. 2,312 ft.; top sd. 2,552 ft.; tstd. S.O. and S.W. 2,554 ft.; will P.B.

M. S. Slagle et al No. 1 Chadwick, SW cor. SE NW Sec. 32-8-10. R.U.

C. H. Smith No. 1 Sabine Lbr. Co., NE cor. NW NW Sec. 9-7-13. Set 10-in. csg. 66 ft.

J. L. Spier No. 2 Hale, SW cor. NW SW Sec. 1-7-13. R.U. and S.D.

Lee Whitehurst No. 2 First Natl. Bnk., C SE NW Sec. 14-7-13. 7-in. csg. 2,212 ft.; tstd. dry 2,301 ft.; used 3,000 gal. acd.; swbg. to test 2,605 ft.

Zwolle Synd. No. 1 Mansfield Lbr. Co., Sec. 8-7-19. T.D. 4,323 ft.; 5-in. csg. 3,830 ft.; drlg. plug 4,323 ft.; 2,500 gal. acd.; perf. 3,730-70 ft.; tstd. dry; W.O. 3,770 ft.; O.T.D. 4,323 ft.; sqzd. off perf.; set short string 4-in. csg. 3,883 ft. and perf. 3,861-70 ft. and 3,880-83 ft.; arng. test; O.T.D. 4,323 ft.

Tensas Parish

H. V. Schumacker No. 4 Mound Plantation, Sec. 29-11-12e. Rmg. to bttm.; T. D. 2,450 ft.; S.D. for D.S.T. 2,450 ft.

Webster Parish

Hunt Oil Co. No. 9 Babb, C N WSE Sec. 14-21-10. Drlg. anhy. 4,060 ft.

Hunt Oil Co. No. 2 Davis Unit, C NW NW Sec. 24-21-10. Hollw. sd. 5,595-5,603 ft.; set 9⅝-in. csg.; did not test Hollwy. sd.; drlg. sh.&L. 7,848 ft.

Hunt Oil Co. No. 10 Davis, C SE SE Sec. 13-21-10. Hollwy. sd. 5,674-78 ft. and 5,719-27 ft.; 9⅝-in. csg. 5,660 ft.; tstd. small S.O. 6,038 ft.; Hollwy. sd.; drlg. sh.&L. 7,321 ft.

Hunt Oil Co. No. 22 Hope Est., C SE SW Sec. 24-21-10. Top Tr. Pk. 5,633 ft.; set 9⅝-in. csg. 5,700 ft.; T.D. 5,900 ft.; Hollwy. sd. 5,722-38 ft.; blew with gas 128 bbls. in 14 hrs.; tstg. 5,900 ft.

Hunt Oil Co. No. 1 Sandifer, C NE NE Sec. 4-20-10. No Hollwy. sd.; top "D" sd. 8,534 ft.; S.O. 8,534-50 ft.; "D" sd. 8,537-68 ft.; Bodcaw sd. 8,628-68 ft.; set 7-in. csg. 8,715 ft.; perf. csg. 8,540-65 ft. and tstd. S.W.; will sqz. and retest; T.D. 8,600 ft.; O.T.D. 8,720 ft.

Magnolia Pet. Co. No. 4 Branton, NE cor. Sec. 6-22-9. Drlg. anhy. 4,563 ft.

Magnolia Pet. Co. No. 1 Merritt Unit, C SW NW Sec. 14-21-10. Top Tr. Pk. 5,715 ft.; no Holloway; 9⅝-in. csg. 5,850 ft.; Bodcaw sd. 8,463 ft.; 7-in. 8,465 ft.; T.D. 8,491 ft.; comp.; 596 B.P.D. dist.; ½-in. ck. and est. 10,000,000 ft. gas; T.P. 2,000 lbs.; C.P. 2,500 lbs.

Magnolia Pet. Co. No. 1-C Pardee, C NW NE Sec. 17-23-11. Rmd. and set 9⅝-in. csg. 5,920 ft.; top lower Marine 7,998 ft.; 8,505-10 ft. strks. hd. sd., O. &G. odor; cd. 8,537-39 ft.; 2-ft. sd. gas odor; drlg. sh.&hd. sd. 9,209 ft.

Midstates Oil Corp. No. 1 Welori Lbr. Co. Unit, NE cor. NW Sec. 3-20-10. 9⅝-in. csg. 5,699 ft.; top lower Marine 8,120 ft.; "D" sd. 8,521-53 ft.; Bodcaw sd. 8,619-65 ft.; sat in each; gas-oil contact in Bodcaw sd. 8,397 ft. sub-sea; perf. in "D" sd.
North American Oil Consol. Co. No. 4 Stewart-Coyle, C NW SE Sec. 29-21-10. Drlg. sh. 3,330 ft.
Ohio Oil Co. No. 5 Bodcaw, Acct. 5, Sec. 13-21-10. Drlg. L.&sh. 5,360 ft.
Ohio Oil Co. No. 51 Bodcaw Acct. 2, NE cor. Sec. 15-21-10. Drlg. sd.&sh. 6,965 ft.
Ohio Oil Co. No. 1 W. Cox, Acct. 2, SE cor. SW Sec. 15-21-10. No Hollwy. sd.; 9⅝-in. csg. 5,714 ft.; drlg. sdy. L.&sh. 8,154 ft.
Ohio Oil Co. No. 8 B. Sydney Hrs., SW cor. Sec. 16-20-10. No Hollwy. sd.; 9⅝-in. csg. 5,670 ft.; W.O.C. 5,952 ft.
Oliphant Oil Corp. No. 1 Fred Banks, C SE NW Sec. 2-20-10. Set 9⅝-in. csg. 5,616 ft.; cleaned hole 7,480 ft.; W.O.
Oliphant Oil Corp. No. 1 Gray & Stephens, C SE SW Sec. 35-21-10. Drlg. sh. 5,637 ft.
Oliphant Oil Corp. No. 1-B Stewart, C NW NE Sec. 5-20-10. Top Tr. Pk. 6,117 ft.; Holloway sd. 6,160-67 ft.; 9⅝-in. csg. 5,884 ft.; top "A" sd. 8,378 ft.; "B" sd. 8,578 ft.; top "D" sd. 8,658 ft.; top Bodcaw sd. 8,747 ft.; both sds. no odor or stain; sh. 5,637 ft.; cd. Davis sd. 9,003-06 ft.; odor gas; cg. sd. 9,091 ft.
Oliphant Oil Corp. No. 2-B Stewart, C NW NW Sec. 4-20-10. No Hollwy. sd.; 9⅝-in. csg. 5,615 ft.; drlg. sd. 8,108 ft.
Sibley Sabine No. 1 McDonald, NW cor. Sec. 32-17-9w. Top anhy. 4,598 ft.; top M. anhy. 4,884 ft.; b. stringer anhy. 5,226 ft.; drlg. sh.&L. 6,050 ft.
Stanolind O. & G. Co. and W. Delaney No. 1 Pardee-Coffee Unit, C NE Sec. 36-21-10. Drlg. anhy. 4,594 ft.
Stanolind O. & G. Co. and Hunt Oil Co. No. 1 Pardee-Coffee Unit, C NE NE Sec. 36-21-10. Top Tr. Pk. 5,897 ft.; no Hollwy.; 9⅝-in. csg. 5,944 ft.; drlg. sh.&sd. 6,682 ft.
Stanolind O. & G. Co. No. 1 Webster Inv. Co., C NE NE Sec. 35-21-10. 13⅜-in. csg. 737 ft.; no Hollwy. sd.; top Tr. Pk. 5,680 ft.; 9⅝-in. csg. 5,997 ft.; drlg. sh.&sd. 6,872 ft.
Union Prod. Co. No. 1 Walker Unit, 50 ft. S, C SE Sec. 30-18-8. R.U.
Woodley Pet. Co. No. 1 Couch, C NW SW Sec. 36-21-10. 13⅜-in. csg. 664 ft.; drlg. sh.&L. 5,803 ft.

SOUTH LOUISIANA FIELDS

Abbeville—Vermilion Parish

Continental Oil Co. No. 1 Franciol, Sec. 67-12s-3e. Drk.

Bancroft—Beauregard Parish

Geo. E. Lilly et al No. 1 W. K. Rice, Sec. 15-6s-13w. Drlg. sdy. sh. 6,325 ft.
Republic Prod. Co. No. 2 Columbia Ld. & Tmbr. Co., Sec. 16-6s-13w. T.D. 3,400 ft.; P.B.; sdtrkd.; T.D. 7,360 ft.; 7-in. csg. 7,352 ft. (cor.); perf. csg. 7,294-99 ft.; fsg. for tbg.
Republic Prod. Co. No. 3 Columbia Ld. &Tbr. Co., Sec. 16-16s-13w. Drk.
Republic Prod. Co. No. 2 Lutcher Moore Lbr. Co., Sec. 16-6s-13w. T.D. 7,297 ft.; top oil sd. 7,260 ft.; 7-in. csg. 7,297 ft.; gas sd. 7,097-7,106 ft.; drld. out 7,370 ft.; perf. csg. 7,283-85 ft.; made sqz. job.
Republic Prod. Co. No. 3 Lutcher Moore Lbr. Co., Sec. 16-6s-13w. Loc.

Bateman Lake—St. Mary Parish

Texas Co. No. 2 State-Bateman Lake, Sec. 21-16s-12e. Loc.
Texas Co. No. 1 Wax Bayou, Sec. 21-16-12e. T.D. 11,185 ft.; 7⅝-in. csg. 11,126 ft.

Baton Rouge—East Baton Rouge Parish

Geo. Helis et al No. 1 Aztec Oil & Roy. Co., Sec. 41-8s-1w. Drlg. sh. 6,564 ft.
Wm. Helis No. 3 Duplantier, Sec. 65-7s-1w. T.D. 6,820 ft.; P.B. 6,788 ft.; perf. csg. 6,775-78 ft.; flwd. oil and S.W.; killed to rework.

Bayou Blue—Iberville Parish

Humble O. & R. Co. No. 9 Wilberts Sons Lbr. Co., Sec. 66-9s-11e. Loc. abd.
Humble O. & R. Co. No. 10 Wilberts, Sec. 66-9s-11e. Drlg. sdy. sh. 4,398 ft.

Bayou Bouillon—St. Mary Parish

Transcontinental Oil Co. No. 5 State, Sec. 13-9s-9e. R.U.R.

Bayou Choctaw—West Baton Rouge

La. Crusader No. 4 Schwing, Sec. 29-8s-11e. Drlg. sh.&shlls. 2,308 ft.
La. Crusader No. 5 Schwing, Sec. 29-8s-11e. Drk.

Bayou Des Allemands—St. Charles Parish

Amerada Pet. Corp. No. 1 Gheens Realty Co., sec. 56-15s-20e. T.D. 7,021 ft.; D.P. stk.; P.B. to 5,000 ft.; sdtrkd. at 5,000 ft.; drld. to 6,984 ft.; 9⅝-in. csg. 6,982 ft.; T.D. 8,266 ft., salt; P.B. 8,150 ft.; D.S. stk.; sdtrkd.; T.D. 8,217 ft.; 6⅝-in. csg. 7,332 ft.; perf. csg. 7,239-54 ft.; F. 83 bbls. in 3 hrs.; ¾-in. ck.; tstg.

Big Lake—Cameron Parish

Union Sulphur Co. No. 1 Hebert, Sec. 18-12s-8w. T.D. 10,521 ft.; P.B. 9,160 ft.; perf. csg. 9,140-57 ft.; I.P. 7 B.O. P.D. with 98% S.W.; perf. csg. 8,210-14 ft.; tstg.; P.B. 8,238 ft.

Caillou Island—Terrebonne Parish

Texas Co. No. 4 State-Terrebonne Bay, Sec. 19-23s-20e. Loc.
Texas Co. No. 5 State, Sec. 19-23s-20e. T.D. 6,240 ft.; sdtrkd.; T.D. 6,521 ft.; P.B.; sdtrkd.; T.D. 6,672 ft.; P.B.; sdtrkd.; drlg. sdy. L. 6,354 ft.
Texas Co. No. 29 State, Sec. 17-23s-20e. Rig.

Cameron Meadows—Cameron

Burton-Sutton Oil Co. No. 26 Sch. Ld., Sec. 16-14s-13w. T.D. 2,465 ft.; 13⅜-in. csg. 2,465 ft.; T.D. 5,171 ft.; fsg.
Magnolia Pet. Co. No. 23 Cameron Meadows, Sec. 21-14s-13w. T.D. 3,934 ft.; 7-in. csg. 3,900 ft.; swbg. 10 B.O.P.D.

Chacahoula—La Fourche Parish

Sun Oil Co. No. 3 Dibert, Stark & Brown Cypress Co., Sec. 70-15s-15e. Drlg. sdy. sh. 5,951 ft.

Charenton—St. Mary Parish

H. L. Edwards et al No. 1 Robichaux, Sec. 30-13s-9e. T.D. 1,782 ft.; 5-in. csg 1,777 ft.; W.O.S.R.
Kinsley Oil, Inc., No. 1-B Hertel, Sec. 30-13s-9e. Loc.
Pan American Prod. Co. No. 10 Veeder, Sec. 30-13s-10e. T.D. 1,668 ft.; 7-in. csg. 1,645 ft.; tstd. S.W.; drld. to 3,050 ft.; P.B. to sdtrk.

Convent—St. James Parish

Continental Oil Co. No. 2 Realty Operators, Inc., Sec. 16. Loc.

Creole—Cameron Parish

Superior Oil Co.-Pure Oil Co No. 3 State-Gulf of Mexico. Top sd. 5,201 ft.; cg. sd. 5,251 ft.

Darrow—Ascension Parish

Humble O. & R. Co. No. 2-B Community, Sec. 55-10s-2e. Drlg. sh.&sd. 6,996 ft.
Humble O. & R. Co. No. 1-B Community, Sec. 31-10s-2e. T.D. 7,280 ft., salt; P.B. 4,596 ft.; sdtrkd.; drlg. sd. 7,143 ft.
Humble O. & R. Co. No. 4 Landry, Sec. 34-10s-2e. R.U.
Kiva Oil Co. No. 1 Duplessis, sec. 69-10s-2w. S.D. 2,523 ft.

Dog Lake—Terrebonne Parish

Texas Co. No. 22 State, Sec. 5-22s-16e. 13⅜-in. csg. 2,030 ft.; drlg. sd.&L. 6,016 ft.

Edgerly Field—Calcasieu Parish

R. H. Kean et al No. 1 M. J. Muller et al, Sec. 29-9s-11w. S.D. 2,825 ft.
Union Sulphur Co. No. 1 Ld. Sulphur Mining Co., Sec. 33-9s-11w. Drlg. sh. 6,016 ft.

Fausse Point—Iberia Parish

Texas Co. No. 5 State Lake-Fausse Point, Sec. 35-11s-8e. Drlg. sh.&L. 6,451 ft.

Gibson—Terrebonne Parish

Shell Pet. Corp. No. 6-B Realty Operators, Sec. 17-17s-15e. Drlg. sd. 2,010 ft.

Garden Island—Plaquemines Parish

Texas Co. No. 30 State, Sec. 38-23s-33e. T.D. 6,943 ft.; fsg. for D.S.

Gillis—Calcasieu Parish

Fohs Oil Co. No. 1 Erwin, Sec. 14-9s-8w. Drlg. sh.&L. 6,128 ft.

Grand Bay—Plaquemines Parish

Gulf Ref. Co. No. 1 State-QQ, Sec. 20s-19e. 13⅜-in. csg. 1,498 ft.; shaley sd. S.O. 6,083-86 ft.; cg. ahead.

Hackberry—Cameron Parish

L. W. Capps et al No. 1 Duhon, Sec. 27-12s-10w. S.D. 75 ft.
Gulf Oil Corp. No. 24 Erwin, Sec. 13-12s-10w. T.D. 3,205 ft.; run 7-in. csg.
Stanolind O. & G. Co. No. 2 Kaugh, Sec. 28-12s-10w. T.D. 3,050 ft.; P.B. 1,508 ft.
Superior Oil Co. No. 4 Benson, Sec. 30-12s-10w. Drlg. sh.&shlls. 5,824 ft.
Texas Co. No. 16-B State-Hackberry, Twp. 12s-9w. Drk.
Texas Co. No. 24-B State, Sec. 12s-9w. T.D. 8,052 ft.; sdtrkd.; T.D. 8,163 ft.; 7-in. csg. 8,050 ft.; perf. csg. 7,902-16 ft.; tstd. S.W.; P.B. 7,780 ft.; perf. csg. 7,763-74 ft.; W.O.S.R.
Union Sulphur Co. No. 7 Caldwell et al Sec. 37-12s-10w. Drlg. sdy. sh. 4,109 ft.
Union Sulphur Co. No. 11 Doiron, Sec. 37-12s-10w. Drk.
Union Sulphur Co. No. 7 Hanzen, sec. 13-12s-10w. T.D. 4,165 ft.; P.B. 4,010 ft.; sdtrkd. 4,083 ft.; T.D. 4,142 ft.; P.B.; sdtrkd.; T.D. 4,102 ft.; abd.

Horseshoe Bayou—St. Mary Parish

Texas Co. No. 2 State, Sec. 37-17s-9e. T.D. 11,644 ft.; S.D.

Jeanerette—St. Mary Parish

Herton Oil Co. No. 1 Adeline Sugar Co., Sec. 39-13s-9e. Loc.
Herton Oil Co. No. 9 Carter, Sec. 38-13s-9e. Drlg. brkn. sd.&sh. 5,562 ft.

Jefferson Island—Iberia Parish

Texas Co. No. 1 State-Lake Peigneur, Twp. 12s-5e. Top salt 3,642 ft.; base salt 3,741 ft.; top salt 7,880 ft.; T.D. 7,897 ft.; 7⅝-in. csg. 7,869 ft.; perf. csg. 7,827-42 ft.; flwd. oil; recovered 182 ft. brksh. wtr.; reperf. csg. 7,827-37 ft.; I.P. 252 B.P.D.; 10/64-in. ck.

Jennings—Acadia Parish

W. T. Burton No. 6 Roboria, sec. 41-9s-2w. 7-in. csg. 6,721 ft.; fsg. tbg.; T.D. 6,997 ft.; sdtrkd. at 6,118 ft.; drld. to 6,178 ft.; sdtrkd. at 6,023 ft.; drlg. sd. 6,656 ft.
Frio Oil Co. No. 1 Iowa-Jennings, Sec. 45-9s-2w. T.D. 6,687 ft.; P.B. 4,300 ft.; T.D. 6,170 ft.; twisted off drill collar fsg.; sdtrkd. 5,550 ft.; T.D. 7,335 ft.; P.B. 2,965 ft.; sdtrkd.; T.D. 6,040 ft.; rmg.
Glassell & Glassell No. 4 McFarlain, Sec. 41-9s-2w. R.U.
Glassell & Glassell No. 6 Trushell, sec 42-9s-2w. T.D. 8,005 ft.; 7⅝-in. csg. 7,973 ft.; drlg. sh. 8,915 ft.
Guaranty Oil Co. No. 2 Houssere-Latrielle, Sec. 47-9s-2w. T.D. 1,750 ft.; 6-in. csg. 1,725 ft.; bld. S.W.; S.D.
Gulf Oil Corp. No. 40 Arnaudet, sec. 48-9s-2w. Drlg. sd.&pyrts. 6,169 ft.
Gulf Ref. Co. No. 1 Lamb, Sec. 45-9s-2w. Drlg. sd. 4,943 ft.
Iles Pet. Co. No. 3 Jennings, Sec. 41-9s-2w. R.U.
L. & L. Oil Co. No. 4 Houssiere Latreille, Sec. 47-9s-2w. Drlg. gbo. 1,200 ft.
Ladak Oil Corp. No. 7 Jennings, Sec 46-9s-2w. T.D. 2,435 ft.
O'Mera et al No. 2 McFarlain, Sec. 41-9s-2w. T.D. 1,625 ft.; 10¾-in. csg. 1,628 ft.
Shell Pet. Corp. No. 5 Community, Sec. 40-9s-2w. Drlg. sdy. L. 5,507 ft.
Stanolind O. & G. Co. No. 113 Crowley & Mineral Co., Sec. 48-9s-2w. Drlg. sh. 4,136 ft.
Superior Oil Co. No. 9 Jennings-Haywood, Sec. 41-9s-2w. Drlg. sd.&sh. 2,269 ft.
Superior Oil Co. No. 15 Leckelt, Sec. 42-9s-2w. Cg. sd. 7,870 ft.
Three Sands Oil Co. No. 2 Clement, Sec. 46-9s-2w. 6-in. csg. 1,700 ft.; T.D. 2,467 ft.; rng. 4½-in. csg.; bld. S.W.; S.D.

Lafitte—Jefferson Parish

Carter-Perrin & Brian No. 1 Lucien Adams, Sec. 9-17s-24e. Drlg. sh. 9,659 ft.
Texas Co. No. 12 LaFitte, Sec. 20-17s-24e. T.D. 10,145 ft.; oil sd.; rmg.
Texas Co. No. 4 Madison Realty Co., 17s-24e. Drlg. sh. 7,040 ft.
Texas Co. No. 1 Sch. Bd., Sec. 16-17s-24e. 13⅜-in. csg. 2,030 ft.; drlg. sdy. sh.&L. 7,612 ft.

Lake Barre—Terrebonne Parish

Texas Co. No. 42 State-Lake, sec. 40-21s-19e. Top salt 11,301 ft.; T.D. 11,333 ft.; 7-in. csg. 11,333 ft.; set 4,369 ft. of 5-in. csg. at 10,545 ft.; perf. csg. 10,460-10,530 ft.; would not flow; reperf. cas. 10,460-10,520 ft.; flowed est. 65 bbls. distillate per day. Killed well reset screen; I.P. 20 bbls. dist., 3,000,000 ft. of gas.

Lake Pelto—Terrebonne Parish

Texas Co. No. 21 State, sec. 8-23s-18e. T.D. 6,058 ft.; P.B. and sdtrkd.; T.D. 5,761 ft.; PB. 5,536 ft.; to sdtrk.; T.D. 6,048 ft.; P.B. and sdtrkd. 5,100 ft.; T.D. 6,041 ft.; P.B. sdtrkd.; T.D. 6,280 ft.; 7-in. csg. 6,200 ft.; perf. csg. 6,105-35 ft.; I.P. 65 B.P.D.; ⅛-in. ck.
Texas Co. No. 22 State, Sec. 8-23s-18e. Drlg. sdy. sh. 3,383 ft.

Leesville—La Fourche Parish

Lincoln Oil Co. No. 6 State, Sec. 26-21s-22e. T.D. 4,242 ft.; P.B. to 3,742 ft.
Texas Co. No. 7 Leeville, sec. 27-21s-22e. T.D. 8,667 ft.; D.S. stk.; sdtrkd.; drlg. sh.&shls. 7,771 ft.

Lirette—Terrebonne Parish

Humble O. & R. Co. No. 1 Laterre, Inc., Sec. 31-19s-19e. 13⅜-in. csg. 3,174 ft.

Lockport—Calcasieu Parish

T. C. Markley No. 1 Farquhar (offset Continental No. 1 J. H. Moss). T.D. 6,733 ft.; P.B. 5,300 ft.; 7-in. csg. 5,320 ft.; perf. csg. 4,607-11 ft.; tstd. S.W.; P.B. 4,441 ft.; perf. csg. 3,806-14 ft.; tstd. mud and S.W.; W.O.S.R.

Lake Long—La Fourche Parish

Fohs Oil Co. No. 6 State-Lake Long, Twp. 17s-19e. 10¾-in. csg. 3,066 ft.; cd. oil sd. 9,365-69 ft.; cg. ahead.

New Iberia—Iberia Parish

H. Fotiades No. 7 Gulf Ld., Sec. 25-12s-7e. Drk.
Wm. Helis No. 6 Bolivar, Sec. 56-12s-7e. T.D. 3,442 ft.; 7-in. csg. 3,408 ft.
Texas Co. No. 2 Bryant, Sec. 25-12s-7e. R.U.
Texas Co. No. 5 Bryant, Sec. 25-12s-7e. Drlg. brkn. sh. 6,081 ft.
Texas Co. No. 1 Gonsoulin, Sec. 13-12s-7e. Drlg. sdy. sh.&L. 8,072 ft.

North Crowley—Acadia Parish

Humble O. & R. Co. No. 4 Federal Ld. Bnk., Sec. 34-8s-1e. Drlg. 120 ft.
Humble O. & R. Co. No. 1 Staker, Sec. 33-8s-1e. 10¾-in. csg. 2,035 ft. T.D. 7,196 ft.; 7-in. csg. 7,193 ft.; I.P. 561 B.P.D.; ⅛-in. ck.

North Tepetate—Acadia Parish

Atlantic Ref. Co. No. 2 Klumpp, Sec. 12-7s-2w. Drlg. sd.&sh. 1,218 ft.

Port Barre—St. Landry Parish

Pan American Prod. Co. No. 1 Rene Nezal. Drk.
V. D. Spill No. 1 Gaudet, sec. 4-6s-5e. S.D. 4,700 ft.

Potash—Plaquemines Parish

Humble O. & R. Co. No. 37 Orleans Lv. Bd., Sec. 23-18s-15e. T.D. 3,035 ft.; fsg.
Western Gulf Prod. Co. No. 1 Paseale, Sec. 6-18s-27e. Loc.
Western Gulf Prod. Co. No. 1 Sam Treadway, Sec. 6-18s-27e. Drlg. sh. 2,658 ft.
Western Gulf Prod. Co. No. 1-A Treadway, Sec. 6-18s-27e. Drlg. sh. 2,115 ft.

Quarantine Bay—Plaquemines Parish

Gulf Ref. Co. No. 5 State, Sec. 17-19s-17e. Loc.
Gulf Ref. Co. No. 6 State, Sec. 17-19s-17e. Drlg. sd.&sh. 3,497 ft.

Raceland—La Fourche Parish

Amerada Pet. Corp. No. 1 Godchaux Sugars, Inc., Sec. 34-15s-19e. 18⅝-in. csg. 262 ft.; T.D. 11,312 ft.; 7-in. csg. 11,312 ft.; T.A.
Amerada Pet. Corp. No. 2 South Coast Corp., Sec. 35-15s-19e. T.D. 12,200 ft., 4¾-in. csg. 10,189 ft.; P.B. 12,164 ft.; perf. csg. 12,049-12,120 ft.; sqzd. perf.; drld. out to 12,135 ft.; perf. csg. 11,840-11,960 ft.; swbd. S.W.; P.B. 7,296 ft.; perf. csg. 7,265-70 ft.; made sqz. job; drld. out to 7,280 ft.; made sqz. job 7,210 ft. and 7,265 ft.; W.O.C.
Amerada Pet. Corp. No. 3 South Coast Corp., Sec. 34-15s-19e. 11¾-in. csg. 2,698 ft.; drlg. sd.&sh. 9,842 ft.
Tide Water Oil Co. No. 1-A South Corp., Sec. 34-15s-19e. Drlg. sh. 10,203 ft.

Sorrento—Ascension Parish

Sorrento Pet. Corp. No. 2 White, Sec. 22-10s-4e. 10¾-in. csg. 1,940 ft.; drlg. sh. 3,810 ft.

South Roanoke—Jeff Davis Parish

Union Sulphur Co. No. 2 T. R. S. Farms, Sec. 23-10s-4w. T.D. 10,854 ft.; drlg.; sdtrk. 9,075 ft.; drilled to 9,266 ft.; stuck D.S.; P.B. 8,860 ft.; W.O.C.

Gueydan—Acadia Parish

A. M. Barbe No. 1 G. L. Humble, Sec. 27-11s-1w. R.U.R.
Buckley et al No. 1 Mulvey Irrig. Co., Sec. 34-11s-1w. Top salt 4,792 ft.; T.D. 4,801 ft.; S.D.
Burton-Sutton Oil Co. No. 1 Valerean-Simon, Sec. 37-11s-1w. Drlg. sh.&L. 5,945 ft.

Timballer Bay—La Fourche Parish

Gulf Oil Corp. No. 4 State, sec. 36-23-21e. T.D. 7,373 ft.; T.D. sdtrkd. hole 6,231 ft.; fsg.; P.B. and sdtrkd. 3,501 ft.; T.D. 6,545 ft.; drld. by jnk. to 6,668 ft.; P.B.; 7-in. csg. 6,651 ft.; top salt 7,224 ft.; T.D. 7,268 ft., salt; P.B. 5,400 ft.; perf. csg. 5,330-40 ft.; tstd. 3,504 lbs. press.; reset screen; would not flow; reset screen; bailed dry; P.B. 5,345 ft.; perf. csg. 5,330-40 ft.; swbd. dry; S.D.

Valentine—La Fourche Parish

Wm. Helis et al No. 4 Valentine Sugars, Inc., Sec. 2-17s-20e. Drlg. sdy. sh. 7,269 ft.
Pan American Prod. Co. No. 2-A Community, Sec. 58-17s-20e. Drlg. sh. 2,484 ft.

Venice—Plaquemines Parish

Tide Water Oil Co. No. 2 Buras Lve. Dist., Sec. 23-21s-30e. 13⅜-in. csg. 1,695 ft.; top salt 3,400 ft.; T.D. 3,463 ft.; P.B.; sdtrkd.; top oil sd. 3,541 ft.; 7-in. csg. 3,619 ft.
Tide Water Asso. Oil Co. No. 9 Manhattan Land & Fruit Co., Sec. 26-21s-30e. Driving piling.

Villa Platte—Evangeline Parish

Continental Oil Co. No. 2 Ludeau-Haas, Sec. 44-3s-2e. R.U.
Continental Oil Co. No. 2 Martha Haas, Sec. 44-3s-2e. Drk.
Continental Oil Co. No. 2 N. H. Hirsch, Sec. 44-3s-2e. Bldg. road.
Continental Oil Co. No. 1 Phillip Fontenot, Sec. 44-3s-2e. Drlg. sh. 424 ft.
Continental Oil Co. No. 1 Adam Tate, Sec. 47-3s-2e. Drlg. sh. 8,862 ft.
Continental Oil Co. No. 2 Tate-McDaniel, Sec. 44-3s-2e. Drlg. sh. 5,368 ft.
Continental Oil Co. No. 2 Vidrine Deville, Sec. 46-3s-2e. T.D. 9,090 ft.; I.P. 354 B.P.D.; ⅞-in. ck.
Texas Co. No. 1 fee, Sec. 27-3s-2e. Drlg. sdy. sh. 9,110 ft.; D.S.T. 8,927-80 ft.; tstd. 1,100 ft. of oil.
Texas Co. No. 2 fee, Sec. 27-3s-2e. Loc.

Vinton—Calcasieu Parish

J. M. Donald et al No. 1 Gordon, Benchenstein-Flynn, Sec. 34-10s-12w. T.D. 1,000 ft.; W.O.C.

West Gueydan—Vermilion Parish

Pure Oil Co. No. 1 Vermilion Irrig. Co., Sec. 41-12s-2w. S.D. 9,865 ft.

Woodlawn—Jeff Davis Parish

Union Sulphur Co. No. 1 Racea, Sec. 12-9s-6w. T.D. 7,268 ft.; fsg.

S. LOUISIANA WILDCATS

Acadia Parish

P. D. Freeman No. 2 J. E. Settig, Sec. 17-7s-1w. S.D. 894 ft.; T.A.
Tri Parish Drillers, Inc., No. 1 Paul Stag, Sec. 4-7s-1w. Drk.
Western Gulf Prod. Co., Sec. 16-10s-1w. Loc.

Assumption Parish

Humble O. & R. Co. No. 1 Milliken & Farwell Co., Inc., Sec. 79-14s-14e. Drk.

Avoyelles Parish

Magnolia Pet. Co. No. 1 W. G. Bowden, Sec. 7-2s-4e. Drlg. sd. 8,846 ft.

Beauregard Parish

Republic Prod. Co. No. 1 Lutcher Moore Lbr. Co., Sec. 14-7s-12w. Top S.W. sd. 8,950 ft.; T.D. 8,980 ft.

Calcasieu Parish

Humble O. & R. Co. No. 1 Desire-Miller, Sec. 32-11s-6w. Drlg. sh. 216 ft.
David B. MacDaniel No. 2 Sch. Ld., Sec. 16-9s-7w. 15½-in. csg. 46 ft.; 10¾-in. csg. 1,299 ft.; prep. to resume operations.

Cameron Parish

Federal Royalty Co. No. 2 State-Calcasieu Lake, Twp. 13s-9w. Loc.

Humble O. & R. Co. No. 2 K. B. Hanzen, 466 ft. S and E. NW cor. SW¼ Sec. 9-12s-6w. T.D. 11,693 ft.; P.B. 11,384 ft.; perf. csg. 8,562-68 ft.; S.G.; perf. csg. 8,562-68 ft.; I.P. 16 bbls. dist., 1,080,000 ft. gas per day; ⅛-in. ck.

Pure Oil Co. No. 3 Calcasieu Natl. Bnk., Sec. 19-12s-4w. Drlg. sh. 2,015 ft.

Iberville Parish

California Co. No. 1 Schwing Lbr. Co., Sec. 96-10s-10e. Dredging canal.

Humble O. & R. Co. No. 1-B A. Wilberts Sons Lbr. Co., Sec. 78-8s-8e. Loc.

La Fourche Parish

Texas Co. No. 1 La Terre, Sec. 1-20s-21e. T.D. 8,898 ft.; 9⅝-in. csg. 8,898 ft.; T.D. 11,135 ft.; 2,509 ft. 6⅝-in. csg. 11,135 ft.; perf. csg. 9,975-10,005 ft.; tstd. 21 stnds. dist.; P.B. 8,600 ft.; drlg. out cmt. to 9,316 ft.; perf. csg. 9,265-90 ft.; failed to flow.

Texas Co. No. 1 State-Catfish Lake, Sec. 77-19s-21e. 18⅝-in. csg. 90 ft.; W.O.C.

Orleans Parish

W. T. Burton No. 2-B Faubourg de Montluzin, Sec. 1-10s-13e. Drlg. sh. 8,510 ft.

W. T. Burton No. 1-B R. E. E. de Montluzin, Sec. 1-10s-13e. Drk.

W. T. Burton No. 1 State-Lake Pontchartrain, Twp. 10s-13e. T.D. 8,367 ft.; P.B. 7,775 ft.; sdtrkd. at 7,959 ft.; T. D. 8,165 ft.; 9⅝-in. csg. 8,165 ft.; T.D. 8,241 ft.; tstd. S.W.; D.S.T. 8,135-8,241 ft.; drlg. sh.&L. 9,024 ft.

St. Bernard Parish

Gulf Ref. Co. No. 4 State-R.R. (Lake Borgne), Twp. 12s-15e. Drlg. sh.&L. 6,965 ft.

Wm. Helis et al No. 1 Mereaux Munez, Sec. 34-12s-12e. Loc.

Vendome Pet. Corp. No. 1 Kenilworth Plantation, Sec. 59-13s-14e. R.U.

St. James Parish

Shell Pet. Corp. No. 1 Shexnayder, Sec. 38-12s-15e. R.U.

St. Landry Parish

Herton Oil Co. et al No. 1 Thistlephlite Lbr. Co., Sec. 60-4s-4e. Drlg. sh.&L. 10,810 ft.; well tried to blow out at 7,000 ft.

St. Martin Parish

Shell Pet. Corp. No. 1 Hazel Burdin, Sec. 15-14s-12e. Cg. L. 9,372 ft.

Texas Co. No. 6 State Lake Mongoulois, Sec. 10-10s-9e. T.D. 9,858 ft.; 7⅝-in. csg. 9,839 ft.; W.O.C.

Texas Co. No. 11 St. Martin Ld. Co., Sec. 21-8s-7e. Top salt 8,904 ft.; T.D 9,404 ft.; 7-in. csg. 8,912 ft.; P.B. 7,175 ft.; drld. out to bttm.; using hole for geophysical work.

St. Tammany Parish

A. P. Portas No. 1 W. C. Forbes, sec 33-7s-15e. Drk.

Terrebonne Parish

Shell Pet. Corp. No. 1 Peters, Sec. 73 18s-18e. T.D. 11,047 ft.; P.B. 10,343 ft.; perf. csg. 10,300-05 ft.; tstd. 450 lbs. press.; 13 stands of oil; run tbg.

Texas Co. No. 1 Continental Ld. & Fur Co., Sec. 29-18s-14e. 18⅝-in. csg. 101 ft.; T.D. 10,039 ft.; P.B. 9,852 ft.; trying to sdtrk.

Texas Co. No. 2 State-Coon Point, Twp 23s-14e. 13⅜-in. csg. 1,900 ft.; drlg. sdy. sh. 1,930 ft.

Vermilion Parish

Stanolind O. & G. Co. No. 2 F. Stovall Sec. 88-14s-3e. T.D. 8,004 ft.; abd.

NORTH MISSISSIPPI

Calhoun County

L. C. Lucas No. 1 E. C. Boland, NW cor. SW Sec. 9-22n-9e. S.D. 755 ft.

L. C. Lucas No. 1 E. C. Boland, 400 ft. E and 500 ft. S, NW cor. SW Sec. 9-22n-9e. S.D. 751 ft.

S. & O. Properties, Inc., No. 1 G. C. Cooner, SE NE Sec. 12-24n-8e. S.D. 2,300 ft.

George County

Cleve Love et al No. 2 J. J. Newman Lbr. Co., C SW Sec. 9-1s-8w. S.D. 7,038 ft., red beds.

Harrison County

Big Ridge Oil Co. No. 1 Hingin, Sec. 13-7s-10w. S.D. 2,700 ft.

Hinds County

G. Jefferys No. 1 Gaddis Farms, Inc., NW cor. SE Sec. 26-7n-4w. S.D. 3,448 ft.

G. Jefferies No. 1 Gaddis Farms, Inc., 700 ft. W line, 545 ft. N line, SE¼ Sec. 26-7n-4w. S.D.; Wilcox 3,448 ft.

Cleve Love et al No. 1 S. F. Johnson NE cor. SE¼ sec. 29-6n-1w. Set 7-in csg. 3,355 ft.; drlg. 4,580 ft.

Cleve Love et al No. 1 S. F. Johnson, NE cor. Sec. 29-6n-1w. Drlg. hd. sd. 4,425 ft.

Southern Nat. Gas Co. No. 1 Progressive Realty Co., SE SW Sec. 35-6n-4w. Drlg. hd. rd. sh. 8,270 ft.

Southern Nat. Gas Co. No. 1 Progressive Realty Co., SE SW Sec. 35-6n-4w Top ch. 6,600 ft.; T.D. 8,458 ft.; abd.

Montgomery County

Dr. T. H. Chichester No. 1 Mitchell, Sec. 36-20n-7e. Drk.

Pontotoc County

Waldrop et al No. 1 Bray, Sec. 17-11s-1e. S.D. 310 ft.

Rankin County

Love Pet. Co. No. 3 Gulf State Creosote Co., Sec. 36-5n-2e. Drlg. bl. sh. 2,273 ft.

Simpson County

Cleve Love No. 1 N. E. Garner, SW cor. SW NE Sec. 1-10n-17w. S.D. 27 ft.

Goodwill O. & G. Co. No. 1 Berry, Sec. 33-2n-4e. S.D. 2,810 ft.

Wilkinson County

La. Crusader Oil, Inc., No. 2 Miss-Wis Tbr. & Ld. Co., SE cor. SW SW Sec. 35-4n-1w. D.&A. 3,375 ft.

Yalobusha County

Acme Holding Co. No. 1 S. D. Boyle, NW NW Sec. 33-25n-7e. D.&A. 2,835 ft.; top Paleozoic 2,808 ft.

FLORIDA

Levy County

Florida Oil Discovery No. 2 Cedar Key Co., Sec. 9-15s-13e. S.D. for csg.; T.D. 3,986 ft.

Nassau County

St. Mary Oil Corp. No. 1 Hilliard, Sec. 19-4n-24e. S.D. 4,575 ft.

Lake County

Union O. & R. Co. No. 1 Gulf Explr., sec. 17-24s-25e. S.D. 235 ft.

Suwanee County

J. W. Phillips Oil Explrn. Co. No. 1 Shilkett, Sec. 14-4s-14e. S.D. 50 ft. for csg.

TEXAS

Week Ending November 12

GULF COAST FIELDS

Hastings Field—Brazoria County

Stanolind O. & G. Co. No. 2-C Cecil Brown, W. H. Snyder Sur. Drk.

Stanolind O. & G. Co. No. 2-B Resof, H.T.&B. Sur. No. 37. T.D. 6,080 ft.; W.O.C.

Stanolind O. & G. Co. No. 5 Roberts, R. A. Magee Sur. Drlg. sd.&L. 5,927 ft.

Old Ocean—Brazoria County

Commerce Oil Co. No. 1 S. M. Patterson, Polly & Chance Sur. Drlg. 1,315 ft.

Harrison & Abercrombie No. 3 Armstrong Plantation, Polley & Chance Sur. S.D. 8,878 ft.

Harrison & Abercrombie No. 2 Chenault, C. Breen Sur. Drlg. sdy. sh. 9,769 ft.

Harrison & Abercrombie No. 1 R. D. McDonald, C. Breen Sur. Drlg. sh.&L. 5,739 ft.

Sun Oil Co. No. 1 Campbell, Chas. Breen Sur. Drlg. sh.&L. 5,056 ft.

Sandy Point—Brazoria County

Stanolind O. & G. Co. No. 1 Sharp, C. S. Corbett Sur. No. 12. T.D. 6,565 ft.; S.W. sd.; cg. ahead.

West Columbia—Brazoria County

General Crude Oil Co. No. 1 Campbell Est., J. H. Bell Sur. Drlg. sh. 6,096 ft.

Texas Co. No. 29 Abrams, G. Tennille Sur. 10¾-in. csg. 1,168 ft.; W.O.C.

Texas Co. No. 9 Phillips, G. Tennille Sur. Drlg. sdy. sh.&L. 3,939 ft.

Cedar Point—Chambers County

Standard Oil Co. of Tex. et al No. 3-118 State. Drlg. sh. 3,010 ft.

Seabreeze—Chambers County

Sun Oil Co. No. 5 Acom, H.T.&B. Sur. No. 103. Drk.

Sun Oil Co. No. 1 Tate, H.T.&B.R.R Sur. T.D. 8,634 ft.; P.B. 2,000 ft. to sdtrkd. at 2,609 ft.; T.D. 8,466 ft.; D. S. stk.

Turtle Bay—Chambers County

Stanolind O. & G. Co. No. 1-38 State (6,000 ft. S of field in Turtle Bay) 10¾-in. csg. 1,212 ft.; drlg. sh.&L. 7,192 ft.

Hitchcock—Galveston County

Maco Stewart No. 8 fee, J. Spillman Sur. T.D. 5,183 ft.; abd.

Maco Stewart No. 9 fee, J. Spillman Sur. Drlg. sh. 2,620 ft.

Wittjen Oil Co. No. 1 Coon, Arthur Burke Sur. R.U.

League City—Galveston County

Mid-States Oil Co. No. 1-A, Maco Stewart, Perry & Austin Sur. Drlg. sh. 2,710 ft.

George Echols No. 1 Maco Stewart-Ross, Lot 3, Perry & Austin Sur. Drlg. sh. 4,226 ft.

George Echols No. 1 Maco Stewart, Perry & Austin Sur. Loc.

Bammel—Harris County

H. M. Lawrence and Geo. Lawrence No. 1 C. Ehrkardt, H. Simmons Sur. R.U.

Clinton—Harris County

Stanolind O. & G. Co. No. 2 Edwards Reels & Trobough Sur. Drk.

Eureka—Harris County

Jack Frazier No. 1 Emma Helberg, J. Reinerman Sur. R.U.

Jack Frazier No. 2 Hogg Bros., J. Reinerman Sur. 10¾-in. csg. 2,505 ft.; T. D. 7,762 ft.; cd. sd.; tstd. sw. 7,726-32 ft.; sqzd. perf.; W.O.C.

Houston Oil Co. No. 3 Helberg & Lackner, J. Reinerman Sur. Loc.

Means & McGehee No. 1-E Laura Lackner, H. Reinerman Sur. Loc.

Tide Water Asso. Oil Co. No. 1 H. H. Ford, J. Reinerman Sur. T.D. 8,113 ft.; 5½-in. csg. 8,700 ft.; perf. csg. 7,762-67 ft.; tstd. S.W.; made sqz. job; W. O.C.

Fairbanks—Harris County

Amerada-Stanolind O. & G. Co. No. 1 Munger, P. B. Hamblin Sur. Loc.

Amerada-Stanolind O. & G. Co. No. 1 Louis G. Williams Sur. T.D. 6,834 ft.; W.O.C.

Amerada-Stanolind O. & G. Co. No. 2 Peters, W. K. Hamblin Sur. and Hogan Sur. Cg. sh. 6,812 ft.

Amerada-Stanolind O. & G. Co. No. 2 White, Jas. Clarkson Sur. T.D. 6,854 ft.; W.O.C.

Briswell O. & G. Co. No. 1 Gibson, Geo. Ayers Sur. T.D. 6,860 ft.; 5½-in. csg. 6,860 ft.; perf. csg. 6,851½-55½ ft.; tstg.; made squeeze job, reperf. csg.

E. M. Hailey No. 1 Albert Brown, J. Clarkson Sur. Loc.

Housh & Thompson No. 1 G. L. Baines, Wiley S. Powell Sur. Cg. sh. 6,823 ft.

Noble & Baker et al No. 1 A. R. Hillegeist, J. Clarkson Sur. T.D. 6,852 ft.; tstg.

Union Prod. Co. No. 1 Fritze, Warneke & Lewis Sur. Drlg. sh. 2,739 ft.

Union Prod. Co. No. 1 Whitehead-Rash-Phillips, W. S. Powell Sur. Drlg. sh. 2,312 ft.

Friendswood—Harris County

Humble O. & R. Co. No. 8-B Goodwin, W. K. Smith Sur. Drlg. sh. 3,020 ft.

Humble O. & R. Co. No. 1 J. L. Jones, Perry & Austin Sur. Drk.

Humble O. & R. Co. No. 15 Gray, Perry & Austin Sur. T.D. 6,037 ft.; W.O.C.

Humble O. & R. Co. No. 3 Settegast, T. Choate Sur. Drk.

Humble O. & R. Co. No. 1 E. E. Watson Drk.

Cordele—Jackson County

Lewis Prod. Co. No. 2 Trushel, I.&G.N. Sur. Drlg. sh. 2,565 ft.

H. J. Porter No. 1 Woussi, Peter White Sur. Loc.

West—Jackson County

Magnolia Pet. Co. No. 5-A West R. Musquiz Sur. Top oil sd. 5,095 ft.; T.D. 5,122 ft.

Clam Lake—Jefferson County

Shell Pet. Corp. No. 3 McFaddin, S. A Pace Sur. 10¾-in. csg. 1,532 ft. T.D. 6,766 ft.; 5-in. csg. 6,028 ft.; P.B. 5,975 ft.; perf. csg. to test.

LaBelle—Jefferson County

Sun Oil Co. No. 4 Broussard-Hebert, B Blackman Lge. T.D. 8,675 ft.; 7-in csg. 8,605 ft.; pmpg. wtr. into hole to kill press. in No. 3 Broussard; made sqz. job; dpnd. 8,680 ft.; fsg. for D.P. S.D.

Hardin—Liberty County

Atlantic Ref. Co. No. 2-B Johnston-Finley, H. B. Johnson Sur. T.D. 7,690 ft.; run csg.

Fohs Oil Co. No. 1 Tompkins, H. B. Johnston Sur. Drlg. sh. 2,712 ft.

Gulf Oil Corp. No. 4 Cessna, H. B. Johnston Sur. R.U.

Humble O. & R. Co. No. 5-A W. S Partlow, H. B. Johnston Sur. T.D. 7,610 ft.; run csg.

Texas Co. No. 1 Smith, A. B. Hardin Sur. Drk.

Tide Water Associated Oil Co. No. 4 Cessna, A. B. Hardin Sur. Spd.

Bay City—Matagorda County

Hamman Explrn. Co. No. 2 Foote, E. Hall Sur. Drlg. 6,510 ft.; no report.

North McFaddin—Matagorda County

Ohio Oil Co. No. 1 Carlson, I.&G.N. Sur No. 2 T.D. 7,729 ft. Recovered 4,560 ft. of oil, 60 ft. of mud and S.W.; cg. sh. 8,250 ft.

Orange—Orange County

C. L. Brown No. 2-B Chesson, Wm. Dyson Sur. Drlg. sh. 2,630 ft.

Gulf Oil Corp. No. 3 Granger, Wm. Dyson Sur. R.U.

Gulf Oil Corp. No 1 La Fleur, Wm. Dyson Sur. T.D. 5,949 ft.; run screen.

John G. Mayo No 1 Seales, Wm. Dyson Sur. 10¾-in. csg. 1,000 ft.; T.D. 6,100 ft.; S.D.

Red Bank Oil Co. No. 1 First Natl. Bank, Wm. Dyson Sur. Drlg. 220 ft.

Red Bank Oil Co. No. 1 Harmon, Wm. Dyson Sur. Drlg. sh. 2,110 ft.

Union Prod. Co. No. 1 Lutcher Moore Lbr. Co., J. Dyson Sur. R.U.

Segno—Polk County

Gulf Oil Corp. No. 4 Ragan, I.&G.N. Sur. No. 15. 10¾-in. csg. 2,160 ft.

Gulf Oil Corp. No. 5 Ragan, I.&G.N. Sur. No. 15. Loc.

Humble O. & R. Co. No. 10-B Kirby Lbr. Co., M. Victor Sur. Loc.

Providence Oil Co. No. 1 Wing, I.&G.N. Sur. No. 14. R.U.

Spurger—Tyler County

Republic Prod. Co. No. 14 Hurd & Hurd Sur. Drlg. sh. 6,312 ft.

GULF COAST WILDCATS

Austin County

Crown Cent. Pet. Corp. et al No. 1 Huehner, Renkestolz Sur. Loc.

Brazoria County

Carroll Oil Co. et al No. 1 N. A. Means, T. J. Green Sur. R.U.

Fabriguze et al No. 1 Freeport Sulphur, Stephen F. Austin Sur. (Bryan Mound). M.I.M.

Humble O. & R. Co. No. 1 Masterson Geo. Robinson Sur. 13⅜-inch csg. 2,402 ft.; drlg. sh. 5,232 ft.

Humble O. & R. Co. No. 1 Tuttle, H.T.&B. Sur. No. 67, Lots 51 and 52. Drlg. sh. 4,310 ft.

Chambers County

Geo. Anderson No. 1 Julia Casey, W. D. Smith Sur. Loc.

F. A. Gillespie et al No. 1 Kirby Lbr. Co., Chambers Co. Sch. Ld. Sur. T.D. 6,523 ft.; 5½-in. csg. 6,471 ft.; perf. csg. 6,415-34 ft.; flwg. oil and wsh. wtr.; well went dead; screen sanded up; reperf. csg. 6,388-6,400 ft. Failed to flow; installing flow valves; jetting with gas.

Humble O. & R. Co. No. 3 Nancy Fiewellen, Benj. Winfree Sur. Drlg. sd. 6,537 ft.

Galveston County

H. C. Cockburn No. 1 O. H. Hardt-Stephen, F. Austin Sur., 2 mi. N of League City discovery well. Drlg. sh. 6,310 ft.

Sun Oil Co. No. 1 R. U. Humphrey, Ruben Barrow Sur. 16-in. csg. 122 ft.; 10¾-in. csg. 2,042 ft.; drlg. sh. 7,651 ft.

Harris County

C. L. Dobbins et al No. 1 Ridgeview Farms, D. Steele Sur. R.U.

Jack Frazier et al No. 1 W. T. Carter, Talcott Patching Sur. Loc.

Jack Frazier et al No. 1 Joe Hornberger, B. N. Cessums Sur. Drlg. sh. 637 ft.

Jack Frazier et al No. 1 Griffith, Adams Smith Sur. Drlg. sh. 4,667 ft.

H. H. Givens No. 2 F. K. Adone, David Middleton Sur. Drk.

Smith & McDannald No. 1 F. Molk, John Gay Sur. 10-in. csg. 1,080 ft.

Jackson County

Chapman Minerals Corp. No. 1 Bennett ranch, Valentine Garcia Sur. Loc.

Crosby Drlg. Co. No. 1 John Broughton, Patrick Green Sur. R.U.

Jefferson County

British American Oil Prod. Co. et al No. 1 Gladys City, J. A. Veatch Sur. (SW flank of Spindletop). Drlg. sh. 7,478 ft.

I. E. Harwell No. 1 State, Gulf of Mexico. T.D. 5,840 ft.; D.S. stk.; pulled in two; S.D.

Humble O. & R. Co. No. 13-B McFaddin-State, Sec. 8. T.D. 134 ft.; W.O.C.

Humble O. & R. Co. No. 1 M. C. Todd, Wm. Carr Sur. Drlg. sh. 7,458 ft.

Matagorda County

Maja Oil Co. No. 1 Robbins, A. Sheppard Sur. R.U.

Montgomery County

Deep South Pet. Corp. No. 1 Foster Lbr. Co., Prevor Brvan Sur. 10¾-in. csg. 700 ft.; T.D. 7,020 ft.; rmg.

Housh & Thompson No. 1 E. B. Clary, Wm. S. Allen Sur. T.D. 4,739 ft.; run csg.

J. Smith et al No. 1 J. V. Scott, F. A. B. Wheeler Sur. S.D. 380 ft.

Orange County

Sun Oil Co. No. 1 Lutcher-Moore Lbr. Co., B. Johnson Sur. T.D. 7,867 ft.; P.B.; sdtrkd.; drlg. sdy. sh. 7,440 ft.

Wharton County

Crown Cen. Pet. Corp. et al No. 1 Ruby Babcock, Samuel B. Middleton Sur. T.D. 3,200 ft.; rmg.

Humble O. & R. Co. No. 1 Duncan, A. Edgar Sur. 13⅜-in. csg. 2,366 ft.; 9⅝-in. csg. 7,370 ft.; T.D. 7,707 ft., sd.; tried to blowout.

S. W. TEXAS WILDCATS

Atascosa County

R. C. Stanley No. 1 Schumann, Simon Malone Sur. No. 1069. T.D. 1,722 ft.; perf. csg. 1,650-75 ft.

Bastrop County

Ira Brown No. 1 T. W. Bailey, John Crutchfield Sur. No. 12. Loc.

R. C. Franklin No. 2 Yarrington, Jose Manuel Bangs Sur. T.D. 2,041 ft.; rng. csg.

A. H. Tarver No. 1 McDuff, Josiah Wilbarger Sur. No. 5. Drlg. 2,210 ft.

Paul Texas and Ashby No. 1 J. T. Grizzard, Andrew Graham Sur. D.S.T. 7,088-23 ft.; recvd. 1 thrib. of mud; S. S.O.; 4¾-in. csg. 7,152 ft.; swbg. salty sulfur wtr.; T.D. 7,175 ft. (cor.); P.B. to 7,150 ft.; W.O.C.

Bee County

Aid and others No. 3 Imogene Hall, Geo. Kerr Sur. T.D. 2,875 ft.
Dirks Brothers No. 1 Robertson, J. G. Morrow Sur. Spd.

Bell County

M. M. Gordon No. 1 Steele, Oliver T. Tyler Sur. S.D. 1,201 ft.
G. P. Shelton et al No. 1 Nelson, Michael Griffin Sur. Drlg. sh. 613 ft. No report.

Bexar County

M. S. Blackburn No. 1 Miller, Thos. Barwick Sur. No. 324. S.O. 151-225 ft.; T.D. 469 ft.; Dobie L.; S.O.; S.D.

Blanco County

D. M. Johnston No. 1 Glasscock, W. W. McDonald Sur. No. 50. 10-in. csg. 150 ft.; S.D. 501 ft.

Caldwell County

R. H. Dye No. 1 Voight, Wm. Watkins Sur. Drlg. 2,800 ft.

Calhoun County

Hiawatha O. & G. Co. No. 2 J. J. Roemer, J. Ogesberry Sur. Drlg. sh. 9,470 ft.

De Witt County

Howeth and Others No. 1 Albrecht, Vincente Ramons Sur. Cg. 4,232 ft.
Marjo Oil Co. No. 1 W. D. McCurdy, John Hunt Sur. S.D. 150 ft.; abd.

Duval County

Frank Gravis No. 2 Schallert, Seale, Morris & Seale Sur. No. 255 (Palagana salt dome). T.D. 3,452 ft.; abd.
Magnolia Pet. Co. No. 1 Duval Co. Rch. Co., G.C.&S.F.R.R. Sur. No. 189. Drk.
S. K. & C. et al No. 1 J. F. Welder, Nathaniel Tinsley Sur. No. 103. T.D. 2,870 ft.; tstg.
F. P. Schwab No. 1 Welder, Sur. No. 103. T.D. 2,974 ft.; abd.
Taylor Ref. Co. et al No. 1 W. F. Afflerback, H. G. Foster Sur. 342. T.D. 1,120 ft.; abd.
Texas Inland Corp. No. 1 Alice Adami, Arnold & Barrett Sur. No. 47. Loc.
R. A. Thompson No. 1 Parr. Julia Rogers Sur. 118. T.D. 5,815 ft.; abd.
W. A. Wagner No. 1 D. J. Weikel, John H. Gibson Sur. No. 497. R.U. and S.D.

Edwards County

Evans & Love No. 1 Steve Brown, Blk. 6, G.W.T.&P. Sur. S.D. 6,261 ft.

Frio County

Humble O. & R. Co. No. 1 Houston et al, M. Rips Sur. 10¾-in. csg. 1,300 ft.; drlg. chk. 4,835 ft.
Humble O. & R. Co. No. 1 Schley, Jos. Travaider Sur. No. 174. 15-min. D.S.T. 3,520-51 ft. tstd. no press.; recvd. 175 ft. mud with oil odor and 180 ft. S. W.; 15-min. D.S.T. 3,595-3,617 ft. tstd. 45 ft. of mud, S.S.O.; recvd. 2,500 ft P.L.O.; D.S.T. 4,720-85 ft.; recvd. 396 ft. sulf. wtr.; D.S.T. Edw. L. 5,271-5,304 ft.; P.B. to 4,800 ft.; 7-in. csg. 4,699 ft.; swbg. 1½ B.O.P.H. plus small amt. of wash wtr. and acd.; P.O.P.; well pmpd. dry on last 4-hr. test; tstg.
Geo. Smith No. 1 Berry. T.C.R.R. Sur. No. 1. Drlg. sh. 3,015 ft.

Goliad County

J. A. English No. 1 Weiss, Cornelius Litts Sur. Drlg. 3,530 ft.
Mills Bennett Prod. Co. No. 1 Geo. Ray, Javiano Gomez Sur. Spd.
Steinberge Pet. Corp. No. 1 Albrecht T. Hancock Sur. T.D. 5,313 ft.; 5-½-in. csg. 5,313 ft.; perf. csg. 5,239-43 ft.; swbg.
Sun Oil Co. No. 1 Lee Homer, John Payne Sur. T.D. 8,308 ft.; abd.

Gonzales County

Hochheim Dev. Trust No. 1 Dubose, E. G. Coffman Sur. 10-in. csg. 37 ft.; S.D. 500 ft.
John Hueners et al No. 1 Bauer, R. E. Brown Sur. Drlg. 1,130 ft.

Guadalupe County

A. D. King No. 1-A Rosenbrock, Vincente Duran Sur. No. 4. T.D. 1,982 ft.; Buda L.; 6-in. csg. 991 ft.; swbg. and flwg. 3 B.O.P.H.
R. A. Williams No. 1 Weber, Guadalupe Torres Sur. T.D. 1,483 ft. (cor.); 4½-in. csg. 1,468 ft.

Hidalgo County

R. E. Hardin et al No. 1 E. M. Car. Hidalgo Co. Canal Subd., Lot 8. Blk 8. T.D. 7,509 ft.; perf. csg. 7,440-65 ft.; tstd. 500,000 ft. gas, 9 bbls. dist.; W.P. 1,700 lbs.
Phillips Pet. Co. No. 1 Flores (deep test N of Samfordyce field). T.D. 5,860 ft.; cmtd. 7⅝-in. csg. 5,847 ft. (protection string); drlg. sh. 9,530 ft.
Union Sulphur Co. No. 1 Am.-Rio Grande Ld. & Ir. Co. (Mercedes). Cmtd. 7-in. csg. 8,417 ft.; T.D. 9,618 ft.; 5½-in. inr. set 8,369-9,618 ft.; tstd. S.W. 9,420-30 ft.; made sqze. job; P.B. 9,390 ft.; perf. csg. 9,372-80 ft.; swbd. S.W and gas; perf. csg. 9,347-52 ft.; tstd. S.W.; perf. csg. 9,255-60 ft.; tstd. S. W.; perf. csg. 9,065-70 ft.; tstd. S.W.; perf. csg. 8,990-9,000 ft.; tstd. S.W.; perf. csg. 8,920-25 ft.; tstd. S.W.; perf. csg. 8,845-50 ft.; flwd. 24 bbls., 51-grav. dist. per day; ⅜-in. ck.; killed to reperf.; sqz. off perf.; prep. to test 8,500-10 ft.; tstd. gas and S.W.; sqzd. perf. csg. 8,480-90 ft.; tstd. gas and S.W.; sqzd.; reperf. csg. 8,075-80 ft., tstd. 450 bbls. fluid, 45 bbls. 22.7 grav. oil; sqzd. off perf.; W.O.C.

Jim Hogg County

Humble O. & R. Co. No. 3 Anna Kelsey Bass, San Raphel gr., 3,732 ft. N of Kelsey field discovery well. Recvd. 500 ft. of oil; 25 lbs. press.; D.S.T. 4,700-56 ft.; cg. ahead.
Johnson & Robinson No. 1 Palacios, Mary Montgomery Sur. T.D. 80 ft.
Navarro Oil Co. No. 1 Guerra, Santa Teresa gr. (7,000 ft. SW discovery, Kelsey field). Loc.

Jim Wells County

LaSalle Viejo Oil Co. No. 1 R. Shaeffer, Martin Christian Sur., Sec. 11. Drlg. sh. 4,355 ft.
Magnolia Pet. Co. No. 1 Moreno, La Trinidad gr. T.D. 6,060 ft.; abd.
Magnolia Pet. Co. No. 1 Samuel Maun, Los Olmos y Loma Bianca gr. R.U.
Magnolia Pet. Co. No. 1 Romano, V. de Garcia Las Animas Sola gr., 1,126 ft. E of discovery well. Cd. sd., gas odor, 6,421-26 ft.; T.D. 8,302 ft.; rng. csg. to test gas sd. 6,421-26 ft.; 7-in. csg. 6,528 ft.; perf. csg.; I.P. 5,865,000 ft. gas, 44 bbls. dist. per day; ⅝-in. ck.
Shell Pet. Corp. No. 1 C. H. Von Blucher, Lucinda Best Sur. T.D. 7,332 ft.; 7-in. csg. 7,332 ft.; perf. csg. 7,327-30 ft.; cg. sh. 7,392 ft.
Transwestern Oil Corp. No. 1 B. H. Dunlap, Sur. 179-181 (1½ mi. SW East Premont field). 18⅝-in. csg. 485 ft.; T.D. 5,107 ft.; sdtrkd.; T.D. 5,194 ft.; 8⅝-in. csg. 5,168 ft.; T.D. 6,766 ft.; 7-in. csg. 6,651 ft.; P.B. 5,855 ft.; perf. csg. 5,365-70 ft.; tstd. 1,700 ft. drlg. mud; sqzd. perf.; W.O.C.

Karnes County

M. W. Brown et al No. 1 Yanta, S. G. Hardaway Sur. Drlg. 1,910 ft.
Formax Oil Co. No. 1 Pflugger, Erasmus Seguin Sur. Drlg. 1,320 ft.
Suttle et al No. 1 McKinney, Luz Navarette Sur. Loc.

Kendall County

Carpenter No. 1 Seidensticker, A. Rodriquez Sur. No. 257. S.D. 518 ft.
C. M. Dewey No. 1 Seidensticker, J. M. Cherino Sur. No. 18. Drlg. 578 ft.
H. N. Reid No. 1 Marguardt. J. Travuso Sur. No. 150½. S.D. 800 ft.

Kerr County

J. O. Hart et al No. 5-E Jeff Love, J. Martinez Sur. O.W.D.D.; T.D. 5,625 ft.; C.O. hole.
H. C. Starkey No. 1-A Saue, T.W.N.G R.R. Sur. S.D. 100 ft.

Kimble County

Plateau Oil Co. No. 1 E. E. Bolts, S Jones Sur. T.D. 1,863 ft.; P.B. 1,430 ft.; 7-in. csg. 1,415 ft.; pmpg. 3 bbls. oil, 3 bbls. wtr., 4 hrs.; pmps. off.
Plateau Oil Co. No. 1 S. J. Davis, N. Mitchell Sur. No. 44. Drlg. L. 850 ft.
Plateau Oil Co. No. 1 Hunger, J. Dujner Sur. T.D. 1,837 ft.; 5½-in. csg. 1,765 ft.; tstg.

Kinney County

Bob Rose No. 2 Gaebler, Dolores Soto de Beales gr. S.D. 50 ft.
C. B. Wardlaw No. 1 Standart, Meliton Valdez gr. S.D. 1,290 ft.; tstg.

Kleberg County

Pure Oil Co. et al No. 1 State Ld., Tr. 68, Laguna Madre Bay, Lse. No. 528. T.D. 9,350 ft.; sdtrkd. 8,268 ft.; T.D. 9,636 ft.; prep. to test.

La Salle County

Lake-Tobian Oil Co. No. 1 O'Connor ranch. Blk 35, Bland & Nelson subd. S.D. 2,575 ft.

Lavaca County

A. C. McCord et al No. 1 Cora Russek, Blk. 33, J. C. Reynolds Sur. (S. of Ezzell). Spd. and S.D.

Lee County

Fred Pederson et al No. 1 Brown Davis Hudson Sur. Cd. L., oil odor, 6,100-12 ft.; cg. Buda L. 6,135 ft.

Live Oak County

R. H. Feltner No. 1 Reed, I.&G.N. R.R Sur. 15. R.U.
Luling O. & G. Co. et al No. 1 Northern Royalty Corp., Thos. Castillo Sur. T.D. 4,300 ft.; abd.
Stewart Oil Co. et al No. 2 Nations, Sec. 18, Simmons subd. Cg. 1,580 ft.

McMullen County

Scarborough & Bigiane No. 1 Matula Emmitt, Jas. Garner Sur. No. 6. T.D. 880 ft.; C.O.
Shumway & Burns No. 2 Shiner, Sec. 53 of Shumway subd. of Shiner rnch. Drlg. 1,112 ft.
Taylor Ref. Co. No. 1 Nueces Ld. & Lvstk. Co., B.S.&F. Sur. No. 115. Loc.

Maverick County

Rio Dev. Co. No. 5 State Bnk. & Trst. Co., G.C.&S.F.R.R. Co. Sur. No. 1. S.D. 45 ft.
Wellington Oil Corp. and Humble O. & R. Co. No. 1 Indio Cattle Co., Antonio Revas gr. T.A. 3,275 ft.

Medina County

C. H. Gannon et al No. 1 Saathoff, G. L. Hemeken Sur. No. 833. T.D. 552 ft.
Victor Ziegler No. 1 Paul Haby, Wm. G. Still Sur. No. 1. T.D. 81 ft.

Nueces County

Catherine Brown No. 1 D. F. Davis, L. A. Patillo Sur. No. 121. R.U.
Humble O. & R. Co. No. 1 Michalek, Lots 4 and 5, Sec. 97, Bishop Out Lot subd. Drlg. sh. 5,390 ft.
Phillips Pet. Co. No. 1 Masten, Blk. 146. Delores I. & A. Co. Sur. Drlg. sh. 7,726 ft.
Seaboard Oil Co. No. 1 Ellen C. Wilson, Jose Vicente Lopez de Herrera gr. Drlg. sh. 4,617 ft.
Stanolind O. & G. Co. No. 1 Geo. R. Clark, Nueces Co. Winter Vegetable Gardens. Drlg. sh. 4,757 ft.
Texas Co. No. 1 E. Little et al, Wm. Little Sur. 10¾-in. csg. 1,174 ft.; T.D. 7,746 ft.; fsg.
Union Prod. Co. No. 1 Minnie Brown (Agua Dulce area). Drlg. sh. 12,152 ft.

Real County

Blakely Smith et al No. 1 Love Ranch. H.E.&W.T.R.R. Co. Sur. Drlg. 495 ft.

Refugio County

G. S. I. et al No. 4 Rooke, Aldrete 6¼ Lge. R.U.
G.S.I. No. 2 Spaulding Aldrete, 6¼ Lge. gr. T.D. 6,356 ft.; perf. csg. 5,896-98½ ft.; killed, too much gas.
Rutherford Oil Corp. No. 1 Neiman, Estaban Lopez Sur. M.I.M.

Starr County

Circle Oil Co. No. 1 Sabas Olivarez, C. C.S.D.&R.G.N.G. Sur. No. 241. 8½-min. D.S.T. 4,560-73 ft.; recvd. 425 ft. oil; 90 lbs. press.; S.D.
Pistol Hill Oil Co. No. 1 Alvarez, J. J. Guiterrez, Porc. No. 72. Loc.
Rhinehart and Bowman No. 1 Bowman, J. C. McCarty Sur. Loc.
Sun Oil Co. No. 1 A. Olivarez, C.C.S.D. &R.G.N.G. Sur. No. 239 (Sun field). 7-in. csg. 5,242 ft.; drlg. sdy. sh. 5,572 ft.
Sun Oil Co. No. 1 Speer, Sec. 274 (1 mi. SW of discovery well. Recovered S.W.; D.S.T. 5,549-67 ft.; T.D. 6,131 ft.; abd.
Transwestern Oil Co. No. 1 Dallas Jt. Stk. Ld. Bnk., Gavino Silvas Sur. R.U.

Webb County

Houser & Campbell No. 1 Puig, Edrington subd. of Alberca De Arriba gr. Drlg. rk. 2,004 ft.
O. W. Killam No. 1 Frost Natl. Bnk., A. Chapa Sur. No. 604. T.D. 2,467 ft.; abd.
Magnolia Pet. Co. No. 1 Duval County School Land. Duval County School Land League No. 101. Loc.

Williamson County

F. J. Anderson No. 1 Teichelman, Absalam Jett Sur. Drlg. sd.&sh. 3,456 ft.
W. O. Caffey No. 1 Fuchs, Francis Bradley Sur. No. 6. S.D. 1,121 ft.
H. H. Coffield and Taylor Ref. Co. No. 1 Galler, H.T.&B.R.R. Sur. No. 7. Drlg. 40 ft.
Duvall Oil Co. No. 1 Gustafson, Rutersville College Sur. T.D. 2,258 ft.; abd.
Fritz Fuchs No. 1 Cain, T. J. Bird Sur. T.D. 1,380 ft.; abd.

Victoria County

Wellington Oil Co. of Delaware No. 1 Boothe, Indianola R. R. Co. Sur. No. 10. S.D. 4,320 ft.

Wilson County

Stapper Oil Co. No. 1 J. McDaniel, L. Manchoca Sur. T.D. 3,200 ft.; fsg.

Zapata County

Joe Martinez No. 1 F. Zaragosa, J. V. Borego gr. Drlg. 730 ft.

EAST TEXAS

(Border Counties)

Cass County

Harry Hanbury No. 1 Echols et al, SE cor. Echols tr., Wm. Mayes Sur. Tstd. S.W. and S.O. 5,987 ft.; P.B. 5,967 ft. and top Young sd. 5,998 ft.; set 58 ft. of 4½-in. csg. 5,998 ft.; T.D. 6,000 ft.; tstd. dry 6,000 ft.; perf. csg. 5,904-44 ft.; tstd. dry 5,944 ft.; ripped csg. 5,968-73 ft.; swbg. S.W. and S.O.; P.B. 5,840 ft. and ripped csg. 5,795-5,835 ft.; tstd. est. 2,000,000 ft. gas; C.I.; W. O.; T.D. 5,840 ft.

Harrison County

F. H. Barnwell No. 1 Smith, A. P. Hope Sur. Drlg. 1,365 ft.

Marion County—Rodessa

Ark.-La. Gas Co. No. 1-B Braden Unit, Devalt Sur. Set 5½-in. csg. 5,994 ft.
Ark.-La. Gas Co. No. 1 Moseley, Alex. Johnson Sur. Drlg. 2,020 ft.
Bender & Killingsworth No. 2 J.&N.W., Wm. Smith Sur. Drlg. sh.&L. 3,887 ft.
Cable Tool Drlg. Co. No. 1 Howard, John Hanks Sur. Drlg. ch. rk. 2,172 ft.
Cable Tool Drlg. Co. No. 1 Schellinger, John Hanks Sur. R.U. and S.D.
Fohs Oil Co. No. 1 Davis, Wm. Smith Sur. 5½-in. csg. 6,022 ft.; acd. with 1,500 gal. and tstg.; T.D. 6,032 ft.
Gulf Prod. Co. No. 2-A Ray, John Hanks Sur. Set 9⅝-in. csg. 1,967 ft.; drlg. sh. &L. 4,724 ft.
Illinois Oil Co. No. 2 Hale, John Hanks Sur. Top Henderson sd. 5,999 ft.; top Gloyd 6,021 ft.; 5-in. csg. 6,020 ft.; T.D. 6,046 ft.; comp.; 7 B.P.H.; ¼-in. ck.; T.P. 50 lbs.; C.P. 150 lbs.
Phillips Pet. Co. No. 2 Henderson, T. Gillespie Sur. Set 10-in. csg. 1,056 ft.; T.D. 1,065 ft.
Shell Pet. Corp. No. 1 Stephenson, G. Perry Sur. 8⅝-in. csg. 1,013 ft.; drlg. L. 4,108 ft.
Texas Co. No. 2 Braden, Jos. M. Fitzgerald Sur. Drlg. sh.&L. 5,726 ft.
Union Prod. Co. No. 10 Hutchinson, A. D. S. Coy Sur. 9⅝-in. csg. 1,019 ft.; drlg. red beds 4,148 ft.
Wrather & Lapin No. 1 Davis, Wm. Smith Sur. 5-in. csg. 6,043 ft.; T.D. 6,056 ft.; comp.; 345 B.P.D.; ¼-in. ck.; T.P. 175 lbs.; C.P. 850 lbs.

Marion County—Other

Capps Bros. Lbr. Co. No. 2 Stiles, Wall Sur. T.D. 2,394 ft.; swbd. dry; shot with 2 qts. nitro at 2,334 ft.; tstd. dry; S.D. 2,394 ft.
Geyer Oil Co. No. 6 Vincent, C. Davenport Sur. T.D. 2,408 ft.; tstg.

Sabine County

Hugo Allen No. 1 Brooks, Isaac Low Sur. S.D. 5,885 ft.; W.O.

Shelby County

Redditt & Gray No. 1 Pickering Lbr. Co., Childers Sur. Set 7-in. 5,080 ft.

WEST TEXAS WILDCATS

Andrews County

Fuhrman Pet. No. 1 G. O. Ashton, sec. 12, Blk. A-42, P.S.L. D.&A. 4,529 ft.
Olson Drlg. Co. No. 1 Lockhart-Brown, 5 mi. W of south end of Fuhrman pool. S.D.O. 4,981 ft.
Texas Co. No. 1-H University, Sec. 4, Blk. 14, Univ. Sur. S.D. 4,542 ft.
J. W. Trippiehorn No. 1 M. A. Thornberry, Sec. 2, Blk. 42-A. Swbg. and tstg. 4,476 ft.
L. H. Wentz No. 1-L W. F. Cowden, Sec. 3, Blk. 43, T.&P. Sur. S.D.R. 4,142 ft.
H. C. Wheeler No. 1 White-Shelton Sec. 18, Blk. 36-A, P.S.L. Sur. Tstg.; T.D. 4,615 ft.

Coke County

Barnett Pet. Co. No. 1 J. R. Mims, Sec. 39. Blk. W, T.&P. Sur. S.D. 1,861 ft.

Culberson County

Harry J. W. Niehaus No. 1 fee, Blk. 109, Sec. 13, P.S.L. Sur. 1,800-ft. test. S.D. 2,500 ft.
Quito Oil Co. No. 1 Cameron Lbr. Co., sec. 24, Blk. 81, P.S.L. Sur. S.D.R. 945 ft.

Dickens County

Bond D. Jones No. 1 Ford et al, I.&G.N. Sur. Drlg. 3,398 ft.

Ector County

Fields et al No. 1 Owenwood, sec. 6, Blk. 44, T.&P. Sur. S.D.O. 4,501 ft.

El Paso County

Tri-State Oil Co. No. 1 Kinkel. S.D. 3,571 ft.

Gaines County

H. J. Brown No. 1 A. L. Wasson, Sec. 51, Blk. AX, P.S.L. Sur. T.D. 4,921 ft.; re-rng. tbg.; 182 bbls., 11 hrs.

Garza County

Gulf Oil Corp. No. 1 Swanson, Sec. 25, Blk. 2, H.&G.N. Sur. Cg. 8,089 ft.

Glasscock County

Crusader Pet., Inc., No. 1 A. D. Neal, Sec. 20, Blk. 33, T.&P. Sur.; 3,200-ft. test. S.D.R. 251 ft.

Hockley County

Snowden & McSweeney No. 1 A. A. Slaughter, Zavalle C.S.L. Sur., Lge. 35, Lab. 74. T.D. 5,069 ft.; 400 ft. O. I.H.; S.D.O. 5,096 ft.
The Texas Co. No. 1-B Mallett Lands, Lab. 1, Lge. 52, Scurry C.S.L. Sur Drlg. 5,009 ft.

Howard County

Parten & Strickland No. 1 O'Daniel, Sec. 39, Blk. 30, T.&P. Sur. W.O.C. 2,530 ft.

Hudspeth County

Haymon Krupp Oil & Ld. Co. No. 1 Thaxton, SE¼ Sec 34, Blk. 74, Twp. 6 U.R. 5,070 ft.; T.D. 5,135 ft.
Haymon Krupp No. 1 Briggs, sec. 24, Blk. 73, Twp. 7, T.&P. Sur. Drlg. 5,304 ft.

Jeff Davis County

Joiner Oil Corp. No. 1 Jones-Coffield. S.D. 3,742 ft.

Lynn County

John L. Baldridge No. 1 Alma Lbr. Co., Sec. 151, H.E.&W.T. Sur. W.O.C. 4,450 ft.

Menard County

C. D. Haggerty No. 1 Callon, sec. 36, Jim Franz Sur. Tools out; making 500,000 ft. gas 1,270 ft.; S.D. 1,270 ft.

Pecos County

E. B. Carruth Tr. No. 1 J. H. Tippett, Sec. 4, Blk. 194, G.C.&S.F. Sur. S.D. 30 ft.
Humble O. & R. Co., No. 1 A. H. Robertson, Sec. 27, Blk. OW, T.C.R.R. Sur.; 4,500-ft. test. Cg. 5,348 ft.
O. E. Schade No. 1 Neville, Sec. 72, Blk. 194, G.C.&S.C. Sur.; 2,500-ft. test. Drlg. 1,595 ft.
O. E. Schkade No. 1 Otis Garrett, Sec. 59½, Blk. 8, H.&G.N. Sur. Spd. and S.D.
Thomason Prod. Co. No. 1 Notions, Sec. 1, Blk. 105, W. P. Howard Sur. Drlg. 869 ft.
S. Thompson No. 1 Elsinore Cattle Co., Sec. 54, Blk. D, G.C.&S.F. Sur. Cg. 6,550 ft.

Reagan County

John W. Emch No. 1 T.&P. Ld. Trust, Sec. 203, Blk. 1, T.&P. Sur. P.B.; W. O.C. 2,718 ft.

Reeves County

Ohio Oil Co. No. 1 Papham, Sec. 18, Blk. 54, T.&P. Sur. Drlg. 5,153 ft.

Scurry County

Coffield & Guthrie No. 1 First Natl. Bk., Snyder, Sec. 29, Blk. 97, H.&T.C. Sur. M.I.M.

Coffield & Guthrie No. 1 E. E. Spears et al, Sec. 130, Blk. 97, H.&T.C. Sur. Tstg. 2,366 ft.; P.B. depth.

Sterling County

J. W. Sward No. 1 Brennand, Sec. 107, Blk. 2, H.&T.C. Sur. S.D.O. 3,011 ft.

Tom Green County

Spinner No. 1 Reed, Mason Ferry Ranch Sur. Fsg. 5,118 ft.

J. B. Watson No. 1 Llano, C.S.L. Sur., Sec. 16. No report; T.D. 705 ft.

Upton County

White & Wilson No. 1 Webb, Sec. 176, Blk. 1, C.C.S.D.&R.G.N.G. Sur. S.D.; csg. 150 ft.

Val Verde County

A. W. Little No. 1 R. W. Sellers, Sec. 34, H.&G.N.R.R. Sur. 1,500-ft. test. Drlg. 1,120 ft.

Ward County

Herschel M. Jaffe No. 1 Viola Meyers, Sec. 17, Blk. 32, H.&T.C. Sur. Drlg. 2,251 ft.

Herschel M. Jaffee No. 1-B Viola Myers. Sec. 17, Blk. 32, H.&T.C. Sur. S.D. 254 ft.

Robt. E. Mitchell No. 1 Allen, Sec. 7, Blk. 32, H.&T.C. Sur. Loc.

Winkler County

S. W. Richardson No. 1-A J. M. Brosahara, Sec. 22, Blk. 77, P.S.L. Sur. Drlg. 3,691 ft.

J. R. Sharp No. 2 Sharp-Crume, Sec. 7, Blk. B-2, P.S.L. Sur. Loc.

Yoakum County

J. E. Mabee No. 1 N. W. Willard, Sec. 741. Drlg. 4,690 ft.

Shell Pet. Corp. No. 1 J. M. Rutts, Sec. 743. Drlg. 5,005 ft.

S. C. Yingling et al No. 1 Nettie Barrier, Sec. 6. S.D.O. 5,501 ft.

TEXAS PANHANDLE

Collingsworth County

Tinsley, White & Knoll No. 1 Frank Knoll, Sec. 62, Blk. 16, H.&G.N. Sur. C.&P.

White No. 1 Wischamper. S.D. 2,263 ft.

Johnson No. 1 Taylor. S.D. 5,650 ft.

Deaf Smith County

Uscan No. 1 Farwell. S.D. 5,650 ft.

Dickens County

Bond Jones No. 1 Foard, I.&G.N. Sur. Drlg. 3,467 ft.

Humble O. & R. Co. No. 1 Matador, Sec. 26, Blk. 1, Shock & Arnold Sur. Contract depth 6,000 ft.

Donley County

Robinson No. 1 Kuteman, Sec. 88, Blk 20, H.&G.N. Sur. Set 6-in. csg. 3,700 ft.

Floyd County

Mills Bennett No. 1 Montgomery, F. J. Latham Sur., 6 mi. S of Floydada. S.D. 5,960 ft.

Gray County

English No. 1 Eudy. S.D. 3,977 ft.

Kent County

B. Dolman et al No. 1 C. V. O'Keefe, Sec. 50, Blk. 1, 15½-in. csg. set at 140 ft.; drlg. at 180 ft. last report.

Lipscomb County

M. C. Tieman No. 1 Spangle, Sec. 626. Blk. 43, H.&T.C. Sur. S.D. 1,880 ft.

Potter County

Sinclair Prairie Oil Co. No. 1 Bush, Sec. 23, Blk. 6, B.S.F. Sur., about 3 mi. N of Amarillo; 8,500-ft. test. Drlg. 5,100 ft.

Roberts County

Whitlock No. 1 Cunningham. Drlg. 3,012 ft. (last report).

E. C. TEXAS WILDCATS

Angelina County

Ginter Bros. No. 4 Copes Hrs., J. Morin Sur., 3 mi. E of Dibol. S.D. 2,214 ft.

Cherokee County

C. C. Lanier No. 1 A. T. O'Neal, J. M. Procella Sur., 3 mi. E of Troup. Loc.

Falls County

W. H. Mahon No. 1 V. H. Moore, N. K. Robinson Sur., between Lott and Rosebud. Spd. and S.D.

Grayson County

Jim McMurrey No. 1 Dr. T. J. Long, J. Garland Sur., 2 mi. S of Collinsville; 4,000-ft. test. S.D.W.O. 3,089 ft.

Henderson County

Tide Water-Seaboard-Humble No. 1 Sadie Starr McGee, R. Acosta Sur., 3½ mi. NE of Murchinson. W.O.C. 207 ft.

Houston County

John G. Mayo No. 1 E. C. Lively, S. Rogers Sur., 4 mi. NE of Grapeland. R.U.

Wynne Drlg. Co. No. 1 May Price, T. Strother Sur., 4 mi. W of Grapeland. M.I.M.

Kaufman County

Sam Knoerr No. 1 J. B. Hunter, P. Walker Sur., 5 mi. S of Terrell. Drk.

W. S. McGee No. 1 Pritchett, J. Hendricks Sur., 7 mi. W of Mabank. Set 5½-in. 3,100 ft.

J. F. McLaughlin No. 1 Wood-Nash, J. C. Cortez Sur., ¾ mi. SE of Scurry. Drk.

Lamar County

Dahl Bros. & Barr No. 2 McQuiston, R. Russell Sur., ½ mi. N of Paris. S.D. 30 ft.

Leon County

T. J. Tucker No. 1 Same Vane, James Webb Sur., 4½ mi. SE of Keechi. P.C. 5,534-44 ft.; swbd. wtr.; prep. perf. csg. Flwd. 12-15 bbls. fluid, 25 per cent water; install separator and tretolite plant; comp.; 171 B.O.P.D.

McLennan County

C. E. Porter No. 1 B. D. Burchett, De la Vega Sur., just SE of Waco. Drlg. 73 ft.; last report.

Lisle Steele No. 1 C. H. Cherry, M. Martinez Sur., 4½ mi. SE of Waco. S.D. 1,300 ft.

Madison County

W. C. Holleman No. 1 D. C. Cannon, J. P. Phillips Sur., 7 mi. NW of Madisonville. S.D. 1,740 ft.

Navarro County

Wilson No. 1 Healer, J. Lothan Sur., 4 mi. W of Richland. S.D. 2,949 ft.

Rains County

McKinley & Hastings No. 1 McTaggert, B. Milder Sur., 1 mi. W of Emory. Loc.

Red River County

Bentley-Sheppard & Stevens No. 1 So. Pine Lbr. Co.; G. S. Parks sur.; 17 mi. N of Clarksville. S.D. 71 ft.

Daniels et al No. 1 J. J. Gaston, J. Guest Sur., 2 mi. S of Detroit. S.D. 1,109 ft.

Rusk County

Drake Drlg. Co. No. 1 R. L. Needham, J. H. Chambers Sur., 3 mi. S of Laneville. Abd. drk.

Smith County

J. H. Thomason No. 1 J. W. Bartlett, R. H. Stewart Sur., ½ mi. SE of Jamestown. S.D. 1,600 ft.

Trinity County

C. D. Davis No. 1 J. D. Gibson, A. Donavan Sur., 4 mi. NE of Trinity. Gas blow out 148 ft.; W.O.C. 232 ft.

Van Zandt County

W. S. King No. 1 Edna W. Watson, M. G. Whitaker Sur., 5 mi. S of Grand Saline. S.D. 2,600 ft.

NORTH TEXAS WILDCATS

Archer County

Sinclair Prairie No. 1 J. A. Hood, Blk. 18, A.T.N.C.L. Sur. 6⅝-in. cmtd. 4,954 ft.; T.D. 5,180 ft.; P.B. 4,976 ft.; W.O.C.

Thurmond & Lipscomb No. 2 L. F. Wilson, E. Hall Sur. A-682. Drlg. 4,205 ft.

Westmount Oil Co. No. 7 T. J. Dempsey, Sec. 10, D.C.S.L. Sur., O.W.D.D. Perf. csg. 4,139-44 ft.; bailing wtr. and tstg.

Baylor County

H. F. Wilcox No. 1 J. E. Fritz, D. Barlow Sur. A-10. S.D.O. 5,277 ft.

Clay County

Walter Gant No. 1 Bryant Edwards, S. C. Beldon Sur. A-12; 6,000-ft. test. 6⅝-in. 5,990 ft.; S.L. 5,994-6,016 ft.; T.D. 6,354 ft.; P.B. 6,069 ft. and shot csg.; treating; acd. 5,794-5,839 ft. through perfs.

Cooke County

Denver P. & R. Co. No. 1 D. B. Allred, De Los Santos Sur. A-894. Drlg. 3,150 ft.

L. C. Heydrick No. 1 F. J. Franklin et al, L. Raney Sur. A-878. Drlg. 500 ft.

Sinclair Prairie No. 2 J. M. Best, T. Toby Sur. A-1054. Drlg. 2,780 ft.

Sussex Oil Corp. No. 1 W. R. Cannon, J. Bradshaw Sur. A-31. 6⅝-in. 1,705 ft.; W.O.C.

Foard County

Helmerich & Payne No. 1 Powers, H.&T.C. Sur., Blk. A. Loc.

Grayson County

O. L. McDougal No. 1 Jackson, H. Coffee Sur., Abst. 204; 4,000-ft. test. S.D. O. 1,700 ft.

J. H. McMurray No. 1 T. J. Long, James Garland Sur. A-441. S.D.O. 3,184 ft.

C. E. Marshall No. 1 F. Christman, M. Ahalt Sur. A-1427. Loc.

Jack County

Marion Church No. 1 S. E. McClure, Sec. 2669, T.E.&L. Sur. Drlg. 1,470 ft.

Noah Daves No. 1 K. D. Baker, Sec. 270, T.E.&L. Sur. 4,000-ft. test. Recem. 10-in. at 90 ft.; S.D.O. 2,320 ft.

Southern O. & G. Co. No. 1 A. Eason, A. D. Kennard Sur. A-328. Spud. and S.D.

Knox County

Roeser Pendleton and I.T.I.O. No. 1 G. H. Beavers, Sec. 151, H.&T.C. Sur. Fsg. 4,690 ft.

Montague County

Lobban et al No. 1 Henry Payne, Wm. Donoho Sur. A-178. Spudded.

H. H. Powell No. 1 Arch Durhan, W. J Wagoner Sur. A-936. S.D.O. 1,800 ft.

Sinclair Prairie No. 1 Hill, Blk. 71, L C.S.L. Sur. Drlg. 1,803 ft.

Youngblood & Foree No. 1 J. A. Burnett, J. Lenow Sur. A-433. 6⅝-in. 4,139 ft.; S.S.O. 4,139-45 ft.; test. S.W. & show oil; S.D.O.

Wichita County

F. S. Freeland No. 1 J. D. Cooper, H. Hastie A-92; 4,000-ft. test. Loc.

Wise County

H. Jackson No. 1 F. Neeley, Blk. 29, Matagorda Co. Sch. Ld. Spud. & S.D.

H. M. Muse No. 1 F. F. Kaker, Blk. 16, Matagorda Co. Sch. Lds. Pits.

Young County

Dean et al No. 1 P. N. King, C. H. Russell Sur. A-1889. Sat. L. 3,727-33 ft.; H. F.O.; tstg.; 5-⅛-in. 3,725 ft.; test. est. 100 B.P.H.

Horwitz & Oldom No. 1 C. J. Taach B, Sec. 248, T.E.&L. Sur. 6⅝-in. 4,113 ft., S.D.O. 5,090 ft.

Italio Pet. Corp. No. 1 H. M. Donnell, Sec. 4, S.P.R.R. Sur. O.S. 3,390-95 ft.; tstg.; 5-⅛ 3,382 ft.

Long & Lupton No. 1 A. Crouch, I.&G. N. Sur. A-1460. Drlg. 1,490 ft.

Pitzer-West No. 1 Robt. Bulloch, J. P. Hume Sur., Abst. 140. Spdg.

WEST CENTRAL TEXAS DISTRICT

Brown County

H. P. Evans No. 1 C. M. Kilgore, Robt Mitchell Sur. No. 141. Prep. shoot 1,134 ft.

Evans No. 1 J. F. Davis, S. Tull Sur. No. 894. Sp. and S.D.

Callahan County

Dobbs Oil Co. No. 1 Finley, sec. 75, Bayland Orphans Home Ld. Fsg. 1,785 ft.

J. C. Jackson et al No. 1 T. J. Thompson, Sec. 30, B.B.B.&C. Sur. T.D. 1,690 ft.; U.R.

Coleman County

Arcadia Ref. Co. No. 1 W. R. Roberts, D. J. Holt Sur. Fsg. 2,685 ft.

Lynn & Jordan No. 1 Eades, J. West Sur., 7 mi. SW of Santa Anna. S.D. 415 ft.

Bob Murray No. 1 Dibrell, H. Kigan Sur., near Camp Colorado. D.&A. 2,865 ft.

Simpson & White No. 1 Baker, M. A. Fisk Sur. No. 630, Abst. 195. Comp.; 4,390,000 ft. gas.

Comanche County

Comanche O. & G. Co. No. 1 J. E. McGuire, C. Rockefeller Sur. No. 3. S.D.O. 1,520 ft.

E. T. DeArman No. 1 Underwood, Sec. 37, D.&D.A. Sur., Abst. 624. T.D. 2,764 ft.; P.B. 2,662 ft.; est. 20 B.O.P.D.; tstg. 2,764 ft.

Loraine No. 1 Carlisle, Sec. 9, Blk. 2, H.&T.C. Sur. M.I.M.

Loraine No. 1 Haile, Sec. 9, Blk. 3, H. &T.C. Sur. C.O. 2,781 ft.; sat. 2,698-2,740 ft.; pmp. 80 B.O. 3 hrs.; T.D. 2,781 ft.; comp.; 15 B.P.D.

Eastland County

J. F. Baker No. 3 N. T. Mulloy, Wm. Ahrenbeck Sur., Abst. 700. C.O. 3,087 ft.

Dobbs Oil Co. No. 1 Greer, J. E. Hardy Sur., Ellenburger test. S.D. 1,738 ft.

Hickok P. & D. Co. No. 1 Penn. Sec. 468, S.P. Sur. Rng. csg. 1,898 ft.

Erath County

Wayne Chandler No. 1 Chandler, J. W Moore Sur., Abst. 571. Drlg. by bit 2,826 ft.

Collard No. 1 W. L. Payton, H. Pierson Sur. No. 1, Abst. 1105. S.D. 185 ft.

Hamilton County

Wallace & Vickers No. 1 C. C. Lund, J P. Bailey Sur. 51. Drlg. 1,310 ft.

Haskell County

Roeser & Pendleton & I.T.I.O. No. 1 M.O. Daugherty, Sec. 19, Wise C.S.L. Sur. W.O.C. 4,900 ft.

Sawyer Drlg. Co. No. 1 A. J. Rowland Est., Sec. 5, Blk. 3, H.&T.C. Sur., 18 mi. E of Stamford. Rng. elec. survey 4,980 ft.

Jones County

Brown Eagle Oil Co. No. 1 Haynes, Sec. 191, Lemuel Andrews Sur. S.D.O. in sd. 2,283 ft.

Brown Eagle No. 1 Waterson, Andrews Sur. No. 191. T.D. 2,283 ft.; S.D.

S. C. Herring No. 1 B. L. Ellis, 330 ft. fr. N and E lines, SE¼ Sec. 8-15, T.&P. Sur. Loc.

Humble O. & R. Co. No. 1 Sam Lewis, 1 mi. S of Hawley pool, C. E. Dewitt Sur. No. 254. Drlg. 1,980 ft.; last report.

S. B. Roberts Co. No. 1 Roy E. Prichard, 205 ft. fr. S L, 2,428 fr. E L, J. E. Cockrell subd. 2, G. Martinez Sur. 195. Loc.

Stiles et al No. 1 Cook, Sec. 89, B.B.B &C. Sur., western part of county Drlg. 3,178 ft.

Ungreen & Frazier No. 1 Griffin, Sec 188, B.B.B.&C. Sur. Flwd. by heads; prep. U.R.; T.D. 3,250 ft.

Nolan County

Chas. E. Peddicord No. 1 Tipton, Sec 43, Blk. 19, T.&P. Sur. Drlg. 2,709 ft.

Union Oil Co. No. 1 J. D. Pepper, Sec. 51, Blk. 21, T.&P. Sur.; 5,000-ft. test 6 mi. SW of Sweetwater. Drlg. 2,540 ft.

Palo Pinto County

Goble-More Drlg. Co. No. 1 M. B. Costello, R. R. Williams Sur., Abst. 896. S.D.O. 2,330 ft.

Parker County

Bartrug & Burns No. 1 Lankin, Sec. 346, T.&P. Sur. S.D. 358 ft.

Glen Rose No. 1 H. D. Groves, SW¼ Sec. 350, T.&P. Sur. S.D., T.D. 685 ft.

Shackelford County

Joe DeGrazier No. 1 Harbough, E cen. part of county, Sec. 1563, T.E.&L. Sur. 4,500-ft. test. Bailing 3,894 ft.

Fox & Rudd No. 1 Shotwell, Sec. 59, B. A.L. Sur. Fsg. 1,622 ft.

R. H. Gordon & Frank Pethybridge No. 1 C. B. Snyder, 330 ft. fr. N and E lines, Sec. 38, L.A.L. Sur.; 4,500-ft. test. Est. 20 to 50 B.O.P.D.; T.D. 3,660 ft.; S.D. 4,293 ft.

J. G. Hammond No. 1 Coker, 1,620 ft. fr. S line and 1,020 ft. fr. W lines, Sec. 159, B.B.B.&C. Sur. S.D.R. 5,209 ft.

Canadian Fields

(Continued from Page 247)

drilling on the Twin dome structure south of Lethbridge where the company holds 30,000 acres.

Taber Field

In the Taber field, southern Alberta, North Taber Royalties No. 1, LSD 7, Section 10-11-15w4, is below 2,200 feet after encountering gas in five horizons between 435 and 1,990 feet, with a particularly strong flow at 620 feet which has been piped for drilling and camp purposes. A strong oil show was met at 2,020 feet. The Sunburst sand is expected around 3,075 feet.

Plains Petroleum Corp. No. 4, LSD 15, Section 25-9-17w4, is in the Madison limestone at 3,482 feet with flow casing at 3,460 feet, and will underream to set casing in the top of the lime.

East Central Alberta

On the Battleview anticline in the Wainwright field, east-central Alberta, Pacalta Oils No. 1, LSD 3, Section 5-48-5w4, is standing at 2,337 feet. Plans are being made to resume in the spring with an experienced United States production engineer in charge. Tests in this area have shown 13 different oil sands, from 2 to 15 feet thick, above the limestone, but some engineering difficulties have been encountered.

Calgary-Edmonton Operations

Shareholders of Calgary & Edmonton Corp., Ltd., at Winnipeg elected the following officers: President, H. F. Osler; vice president, C. R. Disher; directors, Viscount Chaplin, A. H. Douglas, Victor M. Drury, L. D. M. Baxter, H. R. Milner, F. Gordon Osler, Frederick Roche. Negotiations under way will, it is expected, result in the drilling of several new wells.

Saskatchewan Oil Show

In western Saskatchewan, Vera Oilfields No. 2, LSD 5, Section 23-41-24w3, has resumed after a bailing test of crude showings encountered around 2,091 feet. The well was being completed by Franco Oils, Ltd., when it encountered heavy brown asphaltic crude, similar to showings encountered in other tests and same general area. After passing the first horizon, the hole was deepened to 2,121 feet where green crude was encountered. The showings were in the top of the Devonian limestone. Drilling operations have been carried on in the bottom of a fairly deep valley, and every test so far drilled has encountered shows of oil and gas. Bailing samples at No. 2 Vera indicated some water with the crude, but this is believed to come from upper horizons. Considerable crude was swabbed, but the hole was too small to handle production efficiently, and may be enlarged, or another hole drilled. Substantial production is anticipated in the lower Devonian.

California Oil Field Operations For September, 1938

According to figures collected by the American Petroleum Institute, the total production of crude oil in California for September amounted to 19,921,957 bbls., an average of 664,065 bbls. per day. This is a decrease of 5,930 bbls. per day under August production.

Total stocks of crude and all products in Pacific Coast territory increased during the month 2,770,114 bbls. The total stocks at the end of the month were 153,237,753 bbls. The total stock increase for 1938, up to September 30, was 25,197,506 bbls.

Sixty-nine wells were completed during the month with an initial daily production of 53,310 bbls., compared with 102 wells completed during August with an initial production of 71,604 bbls.

CRUDE PETROLEUM PRODUCTION

(Figures of production and stocks are in barrels of 42 gallons)

	Total production	Daily average		
	September	Sept., 1938	Aug., 1938	Sept., 1937
Group 1:				
Belridge—North	376,578	12,553	11,919	16,296
Belridge—South	33,568	1,119	1,070	1,990
Canal	85,630	2,854	2,800	.....
Canfield ranch	2,935	98	93	.....
Coalinga	328,198	10,940	9,878	16,158
Edison	76,666	2,555	2,649	4,054
Elk Hills	312,319	10,411	10,530	11,069
Fruitvale	232,278	7,743	7,806	9,087
Greeley	90,005	3,000	2,994	1,824
Kern River	360,938	12,031	11,431	15,805
Kettleman Middle dome	1,188	40	44	103
Kettleman North dome	1,904,033	63,468	64,729	80,500
Lost Hills	104,470	3,482	3,390	4,142
McKittrick	100,861	3,362	3,313	4,439
Midway-Sunset	1,719,944	57,331	58,647	74,402
Mountain View	290,860	9,695	9,547	18,363
Mount Poso	444,317	14,811	15,108	18,948
Rio Bravo	244,558	8,152	8,058	.....
Round Mountain	405,476	13,516	13,807	13,795
Ten Section	246,553	8,218	7,543	3,263
Wasco	11,299	377	399	.....
Wheeler Ridge	9,294	310	310	318
Group 2:				
Capitan	86,911	2,897	2,698	2,941
Elwood	157,085	5,236	5,472	8,317
Rincon	105,444	3,515	3,669	3,251
San Miguelito	68,853	2,295	2,350	3,332
Santa Barbara	11,390	380	443	599
Santa Maria	587,389	19,580	20,668	12,819
Summerland	953	32	26	25
Ventura Avenue	1,027,135	34,237	34,487	34,935
Ventura-Newhall	159,404	5,313	5,446	5,117
Watsonville	900	30	30	60
Group 3:				
Brea-Olinda	167,935	5,598	5,642	6,140
Coyote—East	98,659	3,289	3,348	4,112
Coyote—West	243,158	8,105	8,227	7,165
Dominguez	751,755	25,059	25,420	29,994
El Segundo	194,971	6,499	7,902	12,688
Huntington Beach	936,244	31,208	31,841	36,048
Inglewood	412,568	13,752	14,130	15,981
Lawndale	1,931	64	80	77
Long Beach	1,678,908	55,964	56,933	59,284
Los Angeles-Salt Lake	17,087	570	438	566
Montebello	371,816	12,394	11,822	8,047
Playa Del Rey	171,819	5,727	5,875	7,847
Potrero	20,331	678	692	236
Richfield	264,601	8,820	9,000	8,786
Rosecrans	427,438	14,248	13,569	3,831
Santa Fe Springs	946,088	31,536	32,709	42,023
Seal Beach	243,550	8,118	8,419	9,296
Torrance	586,273	19,542	17,199	7,620
Whittier	28,724	957	937	913
Wilmington	2,770,669	92,356	94,458	58,778
Total	19,921,957	664,065	669,995	685,184
August	20,769,860	669,995	.....	.....
Decrease	847,903	5,930	.....	.....

OIL FIELD DEVELOPMENT

	New rigs up	Active drilling	Producers completed	Daily initial output	Active producing	Abandoned: Drillers	Abandoned: Producers
Group 1:							
Belridge—North	...	6	...	.....	62	...	...
Belridge—South	...	...	...	.....	86	...	...
Canal	1	2	2	4,029	12	...	...
Canfield Ranch	...	...	...	.....	1	...	...
Coalinga	4	12	3	5,195	808	1	...
Edison	1	...	...	.....	85	1	...
Elk Hills	...	...	...	.....	167	...	...
Fruitvale	1	1	1	161	171	...	...
Greeley	1	3	...	.....	16	...	...
Kern River	4	2	2	26	1,355	...	...
Kettleman Middle Dome	...	...	...	.....	3	...	...
Kettleman North Dome	5	9	3	2,687	204	...	1
Lost Hills	...	...	...	.....	231	...	...
McKittrick	1	1	...	.....	187	...	16
Midway-Sunset	1	4	1	35	2,446	...	...
Mountain View	1	1	...	.....	184	...	...
Mount Poso	2	5	1	220	260	2	...
Rio Bravo	...	7	1	3,925	17	...	...
Round Mountain	6	5	2	255	203	1	...
Ten Section	...	2	2	2,835	31	...	...
Wasco	...	3	...	.....	2	...	...
Wheeler Ridge	...	1	...	.....	28	...	...
Group 2:							
Capitan	...	...	1	940	49	...	...
Elwood	...	...	...	.....	80	...	...
Rincon	...	2	...	.....	46	...	...
San Miguelito	1	3	...	.....	16	...	...
Santa Barbara	1	1	...	.....	33	...	3
Santa Maria	1	3	4	1,971	252	...	1
Summerland	...	...	...	.....	18	...	...
Ventura Avenue	1	8	2	3,734	215	...	...
Ventura-Newhall	...	9	1	265	551	2	2
Watsonville	...	...	...	.....	7	...	...
Group 3:							
Brea-Olinda	2	1	...	.....	338	...	...
Coyote—East	1	...	...	.....	85	...	...
Coyote—West	...	1	...	.....	56	...	...
Dominguez	1	1	3	1,117	202	...	...
El Segundo	...	...	2	710	59	...	2
Huntington Beach	...	...	...	.....	555	1	1
Inglewood	...	...	...	.....	206	...	...
Lawndale	...	...	...	.....	6	...	...
Long Beach	2	2	1	184	1,259	...	...
Los Angeles—Salt Lake	...	...	...	.....	113	...	...
Montebello	1	10	1	673	213	...	2
Newport	...	1	...	.....	...	...	...
Playa Del Rey	...	...	...	.....	190	...	3
Potrero	...	1	...	.....	12	...	...
Richfield	2	1	...	.....	298	1	1
Rosecrans	9	11	3	3,262	103	1	...
Santa Fe Springs	...	...	...	.....	604	...	1
Seal Beach	...	...	...	.....	113	...	...
Torrance	22	31	19	7,086	616	...	...
Whittier	...	...	...	.....	141	...	...
Wilmington	14	15	14	14,000	565	...	...
Miscellaneous drilling	10	41	...	.....	.....	5	...
Group 4: gas fields:							
Buena Vista Lake	...	...	...	.....	1	...	...
Buttonwillow	...	...	...	.....	.....	...	...
Chowchilla	...	...	...	.....	.....	...	...
Delano	...	...	...	.....	.....	...	...
Dudley Ridge	...	...	...	.....	.....	...	...
Goleta	...	...	...	.....	.....	...	...
McDonald Island	...	...	...	.....	4	...	...
Rio Vista	...	...	...	.....	14	...	...
Semi-Tropic	...	...	...	.....	1	...	...
Tracy	...	...	...	.....	1	...	...
Total September	96	206	69	53,310	13,590	15	33
Total August	94	205	102	71,604	13,507	19	18
Increase (*Decrease)	2	1	33*	18,294*	83	4*	15

STOCKS HELD IN PACIFIC COAST TERRITORY BY CALIFORNIA OIL COMPANIES

	Sept. 30, 1938	Aug. 31, 1938	Sept. changes	Dec. 31, 1937 Reclassified
1 Gasoline-bearing crude	33,594,928	33,099,463	+ 495,465	29,417,842
2 Non-gasoline-bearing crude	17,562,544	17,469,970	+ 92,574	14,384,000
3 Unblended natural gasoline	3,402,834	3,356,516	+ 46,318	2,001,204
4 Gasoline, not including distributing and service stations	11,663,318	11,400,449	+ 262,869	13,520,678
5 Naphtha distillates	*1,352,247	*1,324,354	+ 27,893	*1,464,577
6 Gas oil and diesel oil	10,886,653	10,269,247	+ 617,406	8,648,990
7 Fuel oil residuum	69,059,522	67,452,679	+1,606,843	54,145,388
8 All other stocks	5,715,707	6,094,961	— 379,254	4,457,568
Total	153,237,753	150,467,639	+2,770,114	128,040,247
* Estimated amount of unfinished gasoline contained in item No. 5	1,124,050	1,134,150		1,248,291

GULF COAST WATER SHIPMENTS, JULY, 1938

Company—	Coastwise: Crude	Coastwise: Refined	Export: Crude	Export: Refined	Total
Sabine District					
Atlantic P. L. Co.:					
Atreco	1,432,859	.....	.....	.....	1,432,859
Atreco	.....	263,341	.....	300,066	563,407
Burton Terminal:					
Lake Charles	163,531	.....	.....	.....	163,531
Continental Oil Co.:					
West Lake	160,895	.....	.....	.....	160,895
Gulf Oil Corp.:					
Port Arthur	636,912	2,510,706	3	478,395	3,626,016
Magnolia Pet. Co.:					
Beaumont	855,119	1,850,216	.....	.....	2,705,335
Lockport	225,145	.....	.....	.....	225,145
Pure Oil Co.:					
Smith Bluff	.....	1,094,869	.....	.....	1,094,869
Shell Pet. Corp.:					
Haymark	.....	.....	91,486	.....	91,486
Stanolind Crude:					
Beaumont	350,717	.....	175,290	.....	526,007
Sun Oil Co.:					
Beaumont	1,186,502	.....	58,157	.....	1,244,659
Texas Co.:					
Port Arthur	1,242,866	2,810,092	931,030	808,327	5,792,315
Union Sulphur Co.:					
Rose Bluff	204,244	.....	.....	.....	204,244
Total	6,458,790	8,529,224	1,255,963	1,586,788	17,830,768
Rio Grande Valley District					
Valley P. L. Co.:					
Port Isabel	.....	20,511	.....	.....	20,511
Total	.....	20,511	.....	.....	20,511
Houston-Galveston District					
Atlantic P. L. Co.:					
Texas City	147,462	2,386	.....	.....	149,848
Independent Term. Co.:					
Texas City	.....	135,000	.....	189,000	324,000
Humble O. & R. Co.:					
Baytown	.....	2,246,533	.....	954,509	3,201,042
Texas City	494,111	.....	199,606	.....	693,717
Republic O. & R. Co.:					
Texas City	.....	283,000	.....	143,000	426,000
Shell Pet. Corp.:					
Houston	.....	1,749,915	183,613	156,453	2,089,981
Pan American Ref. Co.:					
Texas City	108,394	.....	344,000	.....	452,394
Sinclair Ref. Co.:					
Houston	1,217,006	.....	.....	.....	1,217,006
Texas Co.:					
Houston	532,863	.....	210,112	.....	742,975
Miscellaneous:					
Texas City	85,522	2,229,593	444,468	308,975	3,068,558
Houston	143,919	.....	316,058	.....	459,977
Total	2,729,277	6,646,427	1,697,857	1,751,937	12,825,498
Mississippi River District					
Pan American Ref. Co.:					
Destrahan	137,995	.....	.....	.....	137,995
Shell Pet. Corp.:					
Norco	.....	20,337	.....	225,635	245,972
Standard Oil of La.:					
Baton Rouge	366,927	914,905	.....	313,866	1,595,698
Texas Co.:					
Amesville	529,114	.....	.....	.....	529,114
Total	1,034,036	935,242	.....	539,501	2,508,779
Corpus Christi District					
Atlantic P. L. Co.:					
Harbor Island	566,448	.....	194,530	.....	760,978
General American:					
Corpus Christi	.....	437,544	546,673	257,170	1,241,387
Humble O. & R. Co.:					
Harbor Island	2,561,047	.....	72,105	.....	2,633,152
Texas P. L. Co.:					
Corpus Christi	177,416	.....	404,967	.....	582,383
Miscellaneous	443,770	201,861	1,118,860	600,634	2,365,125
Total	3,748,681	639,405	2,337,135	857,804	7,583,025
Total by Districts					
Sabine	6,458,790	8,529,224	1,255,966	1,586,788	17,830,768
Houston-Galveston	2,729,277	6,646,427	1,697,857	1,751,937	12,825,498
Rio Grande Valley	.....	20,511	.....	.....	20,511
Mississippi River	1,034,036	935,242	.....	539,501	2,508,779
Corpus Christi	3,748,681	639,405	2,337,135	857,804	7,583,025
Grand total	13,970,784	16,770,809	5,290,958	4,736,030	40,768,581

Market Record of Active Oil Stocks

Compiled by Carl H. Pforzheimer & Co., 25 Broad Street, New York City, Member New York Stock Exchange and New York Curb Exchange

New York Stock Exchange

1938 High	1938 Low	Week ending Nov. 12 High	Week ending Nov. 12 Low	Week ending Nov. 12 Close	Stocks—	Total shares outstanding	Par value	Latest dividend	Payable or last paid	Com. sh. earn. 1937	Com. sh. earn. 1938	Dividends paid in 1937	1937 High	1937 Low	1936 High	1936 Low
78	55	72	68⅛	71⅞	Amerada Corp.	788,675	N.P.	50cQ	10-31-38	$3.04	$2.52	$.200	114⅞	51½	125½	75
27⅜	17⅞	24	23¼	23¾	Atlantic Refining	2,663,999	$25	25cQ	12-15-38	3.51	2.59	1.00	37	18	35⅛	26⅝
23¾	12⅛	22½	21¼	21⅞	Barber Asphalt Co.	390,223	$10	75c	12-16-37	1.91	1.14	1.00	43⅜	10⅛	38½	21
21⅜	10⅛	19¼	17⅞	18⅞	Barnsdall Oil Co.	2,250,344	$5	25cQ	11-1-38	0.85	1.01	1.00	35¼	10	28¼	14⅛
10¾	7	9⅝	8⅞	9	Consolidated Oil Corp.	13,915,167	N.P.	20cQ	11-15-38	1.48	1.18	.90	17⅞	7	17¼	11½
35¾	21¼	32	28⅞	31	Continental Oil of Delaware	4,682,583	$5	25cQ	12-20-38	2.98	2.05	1.50	49	24	44⅞	28½
9¾	5	8¾	8	8⅝	Houston Oil (new)	1,098,618	$25	....	10-17-30	0.94	—0.03	....	17⅝	4¾	13⅞	6⅝
22⅝	12¼	17¼	16⅜	16⅞	Mid-Continent Petroleum	1,857,912	$10	35c	12-1-38	2.86	2.57	1.50	35⅜	14	30⅞	17¼
17¾	10⅝	14⅝	13½	14⅝	Mission Corporation	1,382,945	$10	$1	6-29-38	1.31	0.48	1.25	34	15	29⅞	16⅜
23	12½	19½	17	19½	National Supply	1,155,170	$10	$2 pf.‡	12-22-37	4.90	2.02	(‡)	41⅜	17⅝	75½	19⅞
14⅞	8⅞	10⅞	10	10⅞	Ohio Oil Co.	6,563,377	N.P.	50c	12-15-37	1.30	0.70	1.00	22⅞	8	18	12⅛
15⅞	10¼	12⅞	12¾	12⅞	Pacific Western Oil	1,000,000	N.P.	75c	12-15-37	1.39	1.58	.75	29¾	11¾	23½	11⅜
9¼	6½	..	..	..	Pan American Pet. & Trans.	4,702,945	$5	$1*	12-21-37	1.18	0.52	1.00	17⅛	7	20⅝	12¼
44⅜	27½	42½	39⅜	42⅛	Phillips Petroleum	4,449,052	N.P.	50cQ	12-1-38	5.42	4.02	2.75	64	30⅛	52⅝	33½
25⅜	15	22½	21⅜	22⅛	Plymouth Oil Co.	1,029,800	$5	35cQ	9-30-38	2.85	1.65	1.65	29⅞	13	27¾	11⅞
13½	8¼	11½	10¾	11¼	Pure Oil Co.	3,285,120	N.P.	25c	12-1-37	2.15	1.63	.25	24⅜	8¾	27⅞	16
8⅞	5	8	7½	8	Richfield Oil Corp.	3,896,638	N.P.	25c	12-24-37	0.35	...	.25	6½	4⅛	..	..
27½	15½	24	22⅝	23⅝	Seaboard Oil of Delaware	1,244,383	N.P.	25cQ	9-15-38	1.97	2.00	1.00	54⅛	16	44	30½
18⅜	10	15¾	14⅜	15¾	Shell Union Oil	13,070,625	N.P.	35c	7-15-38	1.44	1.57	1.00	34¾	14⅞	28¼	14⅝
34¾	18½	30½	26½	30¼	Skelly Oil	1,003,949	$15	50c	12-15-38	6.07	4.42	1.50	60⅝	26½	47⅜	19½
16⅜	10¾	14⅛	13½	13⅞	Socony-Vacuum	31,151,071	$15	25c	9-15-38	1.82	1.38	.80	23¼	13	17½	12½
34⅞	25⅛	30⅞	29⅝	30½	Standard Oil of California	13,014,754	N.P.	35cQ†	12-15-38	3.17	1.79	2.00	50	27⅛	47⅝	35
35½	24¾	29⅞	28⅞	29⅛	Standard Oil (Indiana)	15,267,030	$25	25cQ	12-15-38	3.66	3.09	2.30	50	26½	48½	32¾
48	32½	..	..	..	Standard Oil of Kansas	112,837	$10	$5	12-20-37	6.93	1.91	5.00	43	30⅝	31	25
58⅜	39¾	55½	53¾	55½	Standard Oil of New Jersey	26,224,767	$25	50c§	12-15-38	5.64	3.73	2.50	76	42	70⅝	51⅛
59	45	55	53	55	Sun Oil	2,316,484	N.P.	25cQ	12-15-38	3.86	3.25	$1 & 8% stk.	77½	44½	91	70
4¼	1¾	3½	3¼	3⅜	Superior Oil Corp.	1,388,079	$1	....	.....	0.32	0.14	....	7¾	1½	6⅜	3
49⅝	32⅝	45⅞	43⅝	45¾	Texas Corp.	10,875,006	$25	50cQ	10-1-38	5.02	4.10	2.25	65⅛	34¾	55¼	28⅞
5⅝	2⅝	5⅜	5	5⅜	Texas Gulf Producing Co.	888,138	N.P.	15c	12-15-38	0.68	0.93	.10	9⅝	2	8⅞	4⅝
12½	7	10⅜	9¾	10¼	Texas Pacific Coal & Oil	888,237	$10	10c	12-1-38	1.11	0.72	.40	16⅝	5⅜	15¼	7½
15¾	10⅛	13⅜	13⅛	13⅜	Tide Water Associated	6,369,175	$10	25cQ	12-1-38	2.08	1.03	1.20	21⅝	13⅛	21⅜	14⅜
22½	17⅛	19¾	19⅝	19⅝	Union Oil of California	4,666,270	$25	30cQ	11-10-38	2.58	1.40	1.40	28¼	17½	28½	20⅝
23½	20	23	22¾	22¾	Union Tank Car Co.	1,200,000	N.P.	30cQ	12-1-38	1.70	1.76	1.60	31½	22	31⅝	22⅝
3½	1⅝	2¾	2⅝	2⅝	Wilcox Oil & Gas	506,522	$5		5-10-28	0.24	—0.06	....	6¼	1¾	5¼	2¾

*Payable in 3½ per cent notes. †Includes extras. ‡One-tenth share $2 preferred stock. §Also 1½ per cent stock dividend.

New York Curb Exchange

1938 High	1938 Low	Week ending Nov. 12 High	Week ending Nov. 12 Low	Week ending Nov. 12 Close	Stocks—	Total shares outstanding	Par value	Latest dividend	Payable or last paid	Com. sh. earn. 1937	Com. sh. earn. 1938	Dividends paid in 1937	1937 High	1937 Low	1936 High	1936 Low
11¾	5	10⅞	10½	10½	American Republic Corp.	1,308,049	$10	10c	7-11-38	$0.27	$0.28	$0.40	10	6⅝		
10¼	4⅞	7⅞	6½	7⅞	Bridgeport Machine Co.	260,000	N.P.	$1.25	12-30-37	1.90	1.26	2.00‡	21⅜	7	21	13¼
39	24¼	29¼	19	29	Buckeye Pipe Line Co.	200,000	$50	50c	12-15-38	4.02	4.40	3.75	51½	36	50	39¾
116	97	116	115½	115½	Chesebrough Mfg. Co.	120,000	$25	$1.50Q†	9-27-38	6.73	7.46	7.00	12	95½	124¾	105
11	5⅛	9	8⅝	9	Cities Service (new)	3,714,317	$10	....	6-1-32	1.02	0.13	....	5⅜	1⅛	7⅜	3
2⅜	⅞	1⅛	1	1	Cosden Petroleum	462,551	$1	....	.....	0.19	..	....	5½	1½	4½	1½
27½	17½	24⅛	22¼	24	Creole Petroleum	6,975,383	$5	50cSA†	12-15-38	1.61	1.23	1.00	38¾	20¼	39	19⅞
10¼	5½	8⅝	8⅛	8½	Darby Petroleum	351,390	$5	25cSA	1-15-39	1.36	1.26	.50	18⅝	6½	18⅛	9
3½	1¾	2	1¾	1¾	Derby Oil & Refining	263,162	N.P.	....	....	1.34	0.66	....	8⅜	2¼	6⅜	1⅞
31	19½	..	..	..	Eureka Pipe Line	50,000	$50	50c	8-1-38	—0.12	—0.62	4.00	47½	24½	47½	38½
46⅞	33	41	39	40¼	Gulf Oil Corp.	9,076,202	$25	25cQ	10-1-38	3.51	2.90	1.00	63½	33	59	36
72⅝	56	66⅛	64¾	66	Humble Oil & Refining	8,987,840	N.P.	62½c	10-1-38	5.22	3.80	2.00	87	54⅞	80	57
19½	14⅛	17¾	17⅝	17⅝	Imperial Oil of Canada	26,965,078	N.P.	62½cSA†‡	6-1-38	0.98	0.95	1.25	24¼	14½	24½	19¾
9⅜	6⅝	..	..	..	Indiana Pipe Line	300,000	$10	20c	11-15-38	1.03	1.00	.80	15	5⅞	9⅜	5½
31¼	21	27⅜	26⅞	27⅜	International Petroleum	14,324,088	N.P.	$1.25†‡	6-1-38	..	1.81	2.50	39½	23½	39⅝	32⅝
5	2¾	3⅜	3¼	3¼	Kirby Petroleum Co.	500,000	$1	10c	4-15-38	0.17	0.20	....	8⅝	2⅜	5⅝	2⅝
25½	15⅝	21	20⅛	21	Lion Oil Refining	434,820	N.P.	25cQ	10-10-38	2.17	1.43	1.50	34	12½	17⅜	7⅜
10⅜	6⅝	10¼	10	10	Lone Star Gas	5,553,747	N.P.	20c	8-20-38	1.14	1.02	.60	14⅛	5¼	14⅛	9⅛
9⅜	6½	7½	7¼	7¼	Louisiana Land & Exp.	2,977,449	N.P.	10cQ	9-15-38	0.58	0.64	.50	15¼	6⅜	15⅜	9⅛
9¾	6⅜	9¾	9⅝	9¾	Midwest Oil Co.	998,444	$10	50c	12-15-38	1.14	0.95	1.00	14⅝	6¼	..	..
5¾	4½	5½	5¼	5¼	Mountain Producers	1,593,584	$10	30cSA	12-15-38	0.76	0.62	.60	7⅜	4⅛	8⅜	5
14⅝	11½	14¼	14⅛	14¼	National Fuel Gas	3,810,183	N.P.	25cQ	10-15-38	0.96	1.19	1.00	19½	12	23	17⅝
9¼	6⅝	7⅝	7	7⅝	National Transit	509,000	$12.50	40c	12-15-38	1.19	0.79	1.00	12½	7¼	15⅜	9¼
2⅝	1⅛	..	..	..	New Mexico and Arizona	1,000,000	$1	1c	12-1-38	0.02	0.02	....	5	1⅜	6⅝	1⅝
4½	4	..	..	..	New York Transit	100,000	$5	15c	10-15-38	0.49	0.34	1.00	5⅜	3⅞	6¼	4¼
6	4	..	..	..	Northern Pipe Line	120,000	$10	15c	12-1-38	0.78	0.66	1.00	12⅜	5⅜	9⅜	4⅞
7⅜	3½	5⅜	5¼	5⅜	Pantepec Oil	2,441,142	$1	....	....	....	0.05	....	9⅝	2⅜	10⅛	3¼
3½	1⅝	2⅛	2	2⅛	Root Petroleum Co.	336,045	$1	25c	2-1-37	—0.17	0.45	.25	12⅜	2	19¼	4½
4	2⅛	2⅜	2⅜	2⅜	Ryan Consolidated	296,931	N.P.	....	.....	0.46	...	....	6½	2¼	4⅜	1⅞
5⅜	3⅜	..	..	..	Southern Pipe Line	100,000	$10	15cSA	9-1-38	0.85	0.41	.45	7¼	3⅞	7⅞	3¼
39	28¾	32¾	31	31	South Penn Oil	1,000,000	$25	37½cQ	9-30-38	4.64	3.59	3.65	56	35	44	32½
22½	19	..	..	..	Southwest Penna. Pipe Lines	35,000	$50	50cQ	10-1-38	0.95	0.97	2.00	42	20	60	44
18¾	15	18	17⅝	17¾	Standard Oil of Kentucky	2,604,790	$10	25c	9-13-38	1.60	1.46	1.50	21⅛	14¾	23⅜	17⅛
8¾	6⅛	..	..	..	Standard Oil of Nebraska	166,403	$25	25c	3-29-37	—0.58	0.42	.25	13¾	8	14⅜	11
22¾	16¼	21⅜	21	21	Standard Oil of Ohio	753,740	$25	25c	12-15-38	3.67	4.77	1.50	45	16	40	21⅜
3¼	2⅛	2½	2⅜	2½	Sunray Oil	2,006,176	$1	10c	12-24-37	0.42	0.26	.25	4⅞	2	5	2⅝
5¼	3½	4¾	4¾	4¾	Texon Oil & Land	936,024	$2	15cQ	9-30-38	0.51	0.36	.45	7⅝	2	9⅜	5⅜
7⅝	4¼	5¼	5	5¼	Transwestern Oil Co.	750,000	$10	....	.....	0.48	0.06	....	13⅞	4⅝	..	..
5¼	2¾	4	3⅝	3¾	United Gas Corp.	7,818,959	$1	...	.....	0.25	0.20	....	13⅞	3	10⅜	4

†Includes extras. ‡Payable in Canadian funds. §Of which $1 was in preferred stock.

PERSONAL

EMBY KAYE, formerly manager of the Idaho Refining Company, Pocatello, Ida., has resigned his position. He has been in California several weeks and he planned to leave early this week to attend a portion of the A.P.I. meetings in Chicago.

CLINT W. JOSEY, secretary, and DON W. JOSEY, treasurer, of the Rancho Oil Company, and MONROE H. GOODE, independent operator, all of Dallas, Tex.; JOHN B. CARTER, general manager of the Gem Oil Company, and T. A. CARLTON, of the Carlton Drilling Company, both of Houston, Tex.; LIP NORVELL, of the Norvell-Wilder Supply Company, Fort Worth, Tex., and L. A. WILKE, of the El Paso (Tex.) Chamber of Commerce, have returned from a hunting trip in the Black Range of New Mexico.

M. M. GARRETT, consulting geologist of Dallas, Tex., has opened a branch office at 1515½ Brockman Street, Mattoon, Ill., with R. R. ANDERSON as resident manager.

HARLEY BYRD, formerly in Sun Oil Company's Tulsa division, has been transferred to Henderson, Ky., where he is in charge of that state's drilling operations for the company.

D. C. BOWLES, formerly connected with the production department of the Huasteca Petroleum Company in Mexico, is now located in the Temblador district of the Standard Oil Company of Venezuela.

R. CHENEY HART, of London, president of the Clyd-Texas Oilfields, Ltd., is en route to Texas to visit his company's properties in the K.M.A. field. Mr. Hart, who landed last week in New York, said he would spend several days renewing acquaintances among eastern oil men.

S. G. JACKSON has been chosen president of the Oil Producers Association in the Oil Springs, Ontario, field. J. H. ANDERSON was elected vice president and F. E. HILLIS secretary. Mr. Jackson and J. T. SPROULE were named to confer with the Petrolia and Bothwell producers associations regarding the recent 20-cent cut in Ontario crude prices.

GEORGE R. SNYDER, port captain for the Sun Oil Company at Marcus Hook, Pa., and WILLIAM LEONARD, Marcus Hook, compressor operator in the gas recovery plant, were recently awarded 30-year service emblems. Since 1908, Captain Snyder has been identified with Sun afloat. Mr. Leonard has been with the Marcus Hook refinery throughout his term of service.

C. B. MANBECK, refinery superintendent for the Standard Oil Company of Indiana at Casper, Wyo., has gone to Alton, Ill., to take charge of the company's plant there.

FREDERICK G. CLAPP, of 50 Church Street, New York, who has been absent in Iran and Afghanistan almost continuously for nearly three years, returned last week on the Normandie to resume his work as consulting geologist.

GOVERNOR E. W. MARLAND announced last Saturday he would leave this week for Washington, D. C., to confer with President Roosevelt and other officials on a plan for modified federal regulation of oil production. Governor Marland said he had abandoned his plan to attend the meeting of the American Petroleum Institute, Chicago.

ALF M. LANDON, Topeka, Kans., independent oil operator and Republican presidential candidate in 1936, has been appointed by President Roosevelt to the delegation of 12 which will represent the United States at the coming conference of American republics in Lima, Peru.

FLOYD SMITH, Mattoon, Ill., and HALL EDWARDS, Midland, Tex., have been made co-directors of the Evansville, Ind., office of the Superior Oil Company of California. When the company is ready to drill it will supplement its office force with a field crew taken from operations in other fields.

C. A. SMITH, JR., chairman of the board and treasurer of the Smith Petroleum Company, Saginaw, Mich., has been named a member of the Special Study Committee of 36 in place of JAMES C. GRAVES, also of Saginaw, who was unable to serve. Announcement of the appointment was made by CHARLES F. ROESER, president of the Independent Petroleum Association of America.

Do You Remember?

From The Oil and Gas Journal Files

25 YEARS AGO

On the Boston lease of Gypsy Oil Company in Section 1-21-7, Osage County, Oklahoma, 12 wells recently completed are producing 14,000 barrels per day.

Kansas, Oklahoma, Texas, and Louisiana combined are producing 263,600 barrels of oil per day. It is an over-supply and so much of the crude is going to storage the market is in danger. The present price averages $1 per barrel.

Ernest J. Nichlos, formerly manager of the Tampico Oil Company of London, England, has located his family in Houston, Tex., and will go into the contracting business in the Mexican fields.

20 YEARS AGO

Joseph Fertig, 83, pioneer oil producer in the Pennsylvania fields, dies in Hydetown, Pa. He was one of five brothers, all oil men.

G. O. W. van Geytenbeck, general manager of the La Corona Petroleum Company, dies of influenza in Tampico, Mexico.

The Humphreys deep well in Section 20-24-1e, Garfield County, Oklahoma, is down 4,300 feet. It has cost $150,000 thus far. Colonel Humphreys says he will drill until he finds oil or runs out of hole.

10 YEARS AGO

John J. Shea, oil attorney and producer, dies of paralysis in Tulsa.

Five important manufacturing concerns in California are purchased by the Byron Jackson Pump Company of Los Angeles and San Francisco, and made a part of the Byron Jackson organization.

The average price of the shares of 20 representative oil companies on the New York Stock Exchange has risen from $64.17 on July 2 to $78.27 on November 12. On the Curb, Gulf Oil Corporation (par $25) touched a new high of $157 per share. Prairie Pipe Line (par $100) hit $224, and Illinois Pipe Line (par $100) reached $259.

A. F. REED, secretary of the Lion Oil Refining Company, has returned to El Dorado, Ark., after a vacation in California.

WARREN W. SMITH, of the New York offices of the Pantepec Petroleum Company, is visiting the Caracas, Venezuela, offices of the company.

W. H. HAGER, petroleum engineer with the Louisiana Department of Conservation in the Cotton Valley field, is spending his vacation in Oklahoma and Kansas.

HARRISON BRYSON, of Petrolia, Ontario, for the past year with Imperial Oil, Ltd., in Toronto, has left for El Centro, Colombia, to join the International Petroleum Company staff.

J. CHILLMAN, director of R. G. Lane, Ltd., London, has arrived in New York for an extended stay in this country in connection with development of the oil brokerage business conducted by his company.

L. R. BRAMMER, sales manager for Danciger Oil & Refineries, Inc., Tulsa; C. L. FOSTER, Keokuk, Iowa, salesman for Danciger in the Illinois-Iowa territory, and RAY C. SMITH, president of the American Petroleum Company, Davenport, Iowa, left for Port Isabel, Tex., last week to try their luck at deep-sea fishing.

W. I. WOODSON is now drilling superintendent for the Texas Petroleum Company (Texas Company) with headquarters in Ciudad Bolivar, Venezuela. The company is moving in its first drilling rig in the Santa Ana district of eastern Venezuela. Mr. Woodson formerly was connected with the Texas Company's operations in Argentina.

PARAGRAPHS

FRANK LEACH, division exploitation engineer in the Tulsa offices of Shell Petroleum Corporation, has been transferred to Wichita, Kans., in an exchange with JOE M. WANAMACHER in the same capacity.

M. S. LAKE, independent producer of Dallas, Tex., and WILLIAM TOBIAN, garage operator of that city, have organized the Lake & Tobian Oil Company and started a wildcat on the O'Connor ranch in northeastern La Salle County, Texas.

F. H. STRELOW, who was pipe line foreman for the Pure Oil Company in the Healdton area of southern Oklahoma, has been transferred to the Edmond district, replacing LEO STANFORD, who went back to Depew. JOHN JEFFREY, who was connection foreman at Healdton, was shifted to Depew also. EARL POLLARD, gauger, was transferred to the Wabash Pipe Line Company, at Olney, Ill. All the transfers result from the sale of Pure's pipe lines in the Healdton district to the Ben Franklin Refining Company.

PAUL G. POTTER, district scout in Kansas for the Shell Petroleum Corporation, has been promoted to chief scout with headquarters in Tulsa. He fills a vacancy created late in 1937 when HENRY LANGSPECHT resigned. CLYDE M. BEEBE, who was brought to Tulsa in September, 1927, as a co-ordinator between the land, scouting and other departments, has been made district scout for the Kansas district and goes to Wichita to succeed Mr. Potter.

M. L. ATKINSON, who was formerly assistant division superintendent at Oklahoma City for the Phillips Petroleum Company, has been made district production superintendent for Seminole and southern Oklahoma. Mr. Atkinson takes the place of W. H. SCHUL, who has been made superintendent of the New Mexico district.

G. H. BLANKENSHIP, elected a director of the Independent Petroleum Association of America at that organization's recent annual meeting, has resigned as a director of the Illinois Independent Oil Producers and Royalty Owners Association. Mr. Blankenship is an independent operator at Centralia, Ill.

W. T. BANNISTER, division manager for the Standard Oil Company of Indiana in the Green Bay division, Wisconsin, and RALPH H. REED, assistant manager, will have a personnel of 145 employes through its enlargement by about 25 per cent with the addition of seven upper Michigan counties. The Green Bay division now contains 22 counties, the largest in Wisconsin and one of the largest in the Middle West. The added territory formerly was supervised from Duluth, Minn.

A. E. GETZENDANER, geologist for the Gulf Oil Corporation at Corpus Christi, Tex., returned last week from a vacation trip to Mexico City.

R. B. KESTER, in charge of the Quiriquire district for the Standard Oil Company of Venezuela in eastern Venezuela, is visiting in the United States.

H. H. BEESON, chief engineer of the Sabine Valley Gasoline Company, Inc., Shreveport, La., is spending his vacation in Ohio and Chicago, attending the A.P.I. convention while in the latter city.

COL. T. H. BARTON, president of the Lion Oil Refining Company, El Dorado, Ark., was honored at a recent celebration arranged by company employes, marking his tenth year as head of the company.

GENE STEELE, petroleum engineer for the Phillips Petroleum Co. in Shreveport, La., will be transferred shortly to Houston, Tex., to which city the Phillips production offices are being moved from Shreveport.

FRANK MALCOLM FARMER was reelected for a third term as chairman of the Engineering Foundation, research organization of major national engineering societies. He is vice president and chief engineer of the Electrical Testing Laboratories, New York.

GORDON W. FIELDER, independent operator of Chanute, Kans., has been turning his attention to drilling activities in the Central Kansas uplift region, and is said to be planning development work in Ellis and Russell counties. Mr. Fielder was associated with JOHN L. RICH in the development of the old Garnett and Bush City shoestrings and in the Lynn City gas field.

So They Sent Ben Cox

When the Socony-Vacuum Oil Company, Inc., this year needed a geological appraisal of its holdings in Egypt Ben B. Cox was sent. He was equipped for that sort of job. And he is there now, directing work on the company's exploratory concessions.

B. B. COX

Mr. Cox entered the petroleum geological field in 1925, when he was engaged by the Palmer Corporation, Shreveport, La., to carry out stratigraphic, structural, paleontological, and mineral-grain research in an area where ordinary stratigraphic methods were not adaptable. The next year the Turkish Petroleum Company (now Iraq Petroleum Company, Ltd.) faced a similar problem in Iraq, and Mr. Cox was sent to handle it. The task finished, he was transferred to the New York office of the Near East Development Corporation, which owns 23.75 per cent of the Iraq Petroleum Company. Upon completion of Iraq's Mediterranean pipe line Mr. Cox was transferred to Socony-Vacuum, which owns 50 per cent of the Near East Development Corporation, and he has been in his present position since March, 1935.

In the summers of 1921 and 1922 Mr. Cox was assistant geologist for the Kentucky Geological Survey, and he was geologist for the Illinois Geological Survey in the summers of 1923 and 1924. For three years, 1922 to 1925, he was instructor in geology in the University of Iowa. Mr. Cox married Nancy Isabella Campbell and they have four children.

W. E. GRAY, district superintendent of the Standard Oil Company of Venezuela at Temblador, has returned home after a vacation, with Mrs. Gray, in Trinidad.

WILLIAM GROUNDWATER, of the Union Oil Company of California, has been reelected a director of the company's employe provident fund for another three-year term.

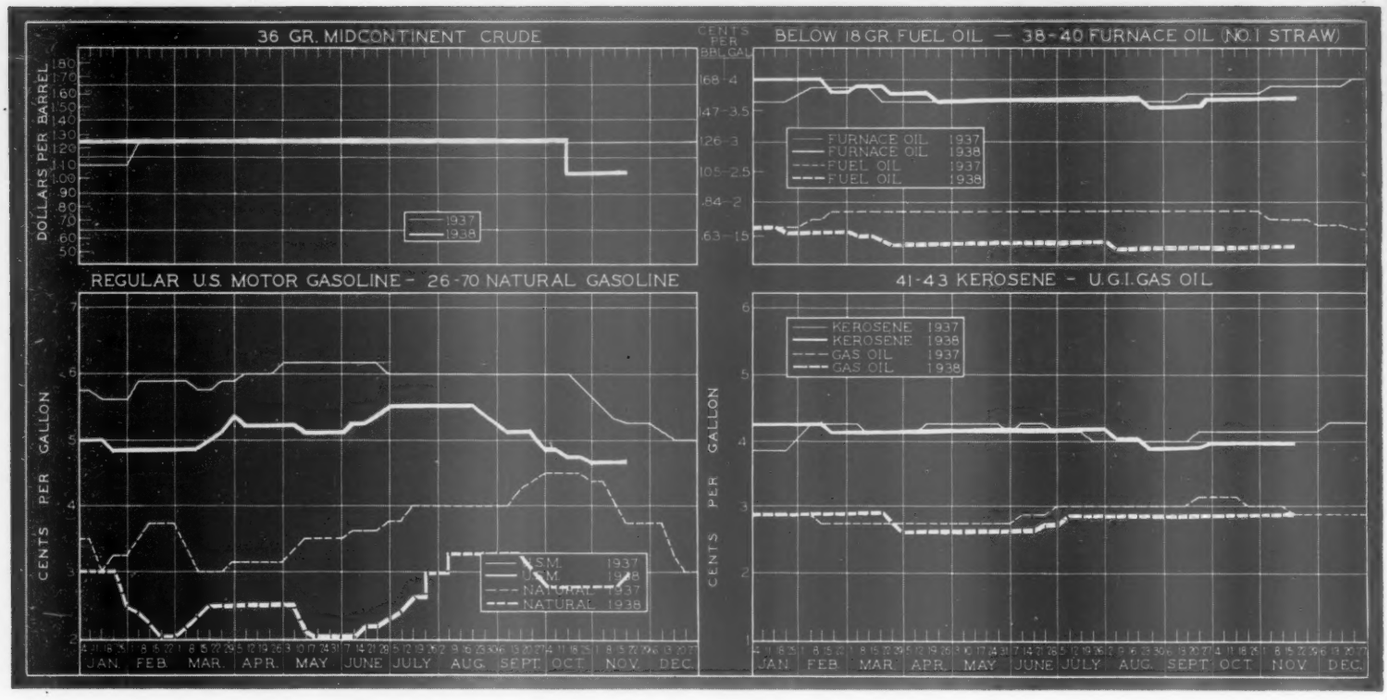
F. A. SUTTON, who formerly was connected with the geological department of the Standard Oil Company of Argentina, is in Caracas, Venezuela, with the Standard Oil Company of Venezuela.

GEORGE S. CLAPP has been transferred by Sun Oil Company from the Tulsa division to Mount Vernon, Ind., where he is field foreman in the Point Township and Heuslar dome operations.

D. VAN NYMEGEN SCHONEGEVEL, manager of the Royal Dutch-Shell refinery at Curacao, Dutch West Indies, sailed from New York last week, returning to his duties after spending several weeks in this country.

SIRO VASQUEZ has been appointed district engineer in the Quiriquire field, Venezuela, for the Standard Oil Company of Venezuela. Mr. Vasquez is a recent graduate of the petroleum engineering school of the University of Tulsa.

EARL WATY, petroleum engineer of the Standard Oil Company of California, and W. S. ACKERMAN, of the Tide Water Associated Oil Company, both of San Francisco, spent several days in Los Angeles preparing supply and demand data with southern California representatives of the American Petroleum Institute's statistical committee.



Representative Mid-Continent Quotations on Crude Oil and Refined Products, Basis Oklahoma (Group 3)

Natural Gasoline Stronger in Group 3 Market and Motor Fuel Steadier

By T. F. SMILEY

Refiners in the Group 3 area were in a more cheerful frame of mind this week, and petroleum products generally were believed to be moving into a better position. Significance was attached to the fact that some of the larger refining companies now are buying not only low-octane gasoline, but the higher grades. For several years many refiners have found it cheaper to buy low-octane gasoline than to make it, but not until recent weeks has the practice been followed in such an extensive way in the case of the higher grades.

Good Investment

No information is at hand as to whether refining companies now buying regular-grade motor fuel are storing it or are using it to fill their own orders, at the same time reducing their plant operations. The assumption is, however, that they regard gasoline at the current level of tankcar prices as a good investment, and that while they may be reselling some of it they are putting a large proportion in tanks to be held there till it commands what it is really worth.

Comments on these interrefinery purchases were uniformly favorable, observers pointing out that they are likely to have a stabilizing influence on the market, besides indicating a conviction on the part of the buyers that gasoline prices have reached an impenetrable bottom.

Movement of motor fuel continued at a high level. "Our sales thus far in November have exceeded those in the corresponding period of October," said one sales manager; and his experience was believed to be fairly typical, for pleasant motoring weather has lingered for a remarkably long period.

Refined Oil Market Barometer

A better tone pervades the market, accompanied by minor strengthening of quotations. Gasoline shipments heavy, but at prices which forbid profitable operation. Naturals up in Oklahoma, affording outlets for overheavy stocks in Texas. Light fuels slow as result of continued warm weather. Demand for heavy oils rises as activity in manufacturing and railroad lines grows.

MID-CONTINENT. Gasoline steadier. Naturals higher. Light fuels draggy. Wax vigorous.

EAST COAST. Gasoline movement heavy, with prices firm. Some shading in light fuels.

GULF COAST Gasoline and Diesel oils weak. Kerosene fairly firm.

CALIFORNIA. Market inactive and all products weak.

PENNSYLVANIA. Gasoline unsettled. Improved demand for industrial lubricating oils.

CHICAGO. Gasoline gallonage heavy, but market soft. Light fuels easy.

Accumulations of cheap gasoline, especially in West Texas, which had been exerting a weakening effect on the market, were reported to be pretty well cleaned up. The volume of underpriced material going out of Louisiana into northern territory was reported to have been much diminished. Low-octane gasoline, which has been an especially vulnerable spot, was getting steadier. Brokers said it was becoming harder every day to get concessions.

Notwithstanding the definitely firmer tone of the gasoline market, refiners declared they still were unable to squeeze a profit out of their operations, and some said they were losing money; for better feeling had not yet been translated into a higher price except in cases where there had been underselling.

Natural Gasoline Up

Natural gasoline, which had been straining at the leash, snapped it in the past week and began rising. Actual scarcity of material prevailed in Oklahoma, increasing the number of outlets for Texas plants and thus establishing a much better balance between the two areas; for in recent weeks there had been too much natural in Texas looking for places to go, and too little in Oklahoma. This better adjustment, along with brisk export demand, invigorated the whole market.

Apparently much the same conditions affecting the natural gasoline market have prevailed in Europe as in this country; that is, mild weather has retarded the use of winter-specification motor fuel, but the arrival of cold days now is demanding a much more volatile material. Several orders for cargoes have been placed lately.

The heating oils were looking up a little with the spreading of cool weather over wider areas. Heavy fuels showed a somewhat better tone, though Mid-Continent refiners said they had not yet felt directly the result of improving conditions in industry. Neutrals and bright stocks were making slow progress. Supplies of cheap material were believed to be falling gradually. Wax was outstandingly strong. Kerosene, though not in active demand, was steady, and prices were holding. U.G.I. gas oil was firm.

Eastern Tankcar Is Supported and Retail Prices Are Firmer

By H. STANLEY NORMAN

NEW YORK, Nov. 14. — Northeastern motor fuel markets, in both price and volume, continue to run counter to the calendar due to prevailing mild weather. Contrary to seasonal expectations, tankcar prices are being well supported and in some of the depressed retail areas conditions are being adjusted upward.

Despite the fact that normally November produces a sharp slump in motor fuel consumption, several refiners report this year is closing with the prospects of a fourth quarter demand materially exceeding 1937. Gasoline prices held steady at practically all Atlantic Coast terminals last week. Reports that 65-octane gasoline could be obtained in some directions at Philadelphia for 5¾ cents per gallon in tankcars were heard last week, but confirmation was lacking and a majority said 6 cents was the minimum. Reports were also heard that the price structure in Baltimore was a shade easier, but there, too, quotations checked were level with those of the preceding week.

Retail prices were reported adjusted upward at Camden, N. J., last week, bringing a majority of stations to 14.4 cents per gallon for regular motor fuel and third grade to 13.9 cents. Camden has been one of the weak spots in retail gasoline distribution for several months. Tank-wagon prices were reported up two-tenths of a cent, making the regular grade 7.4 cents per gallon to undivided dealers, plus taxes.

Northern and eastern Pennsylvania contains a few cities in which retail gasoline prices are still unsettled, but dealers are starting programs to bring their markets in line with that existing at Philadelphia where increases of three weeks ago appear to be permanently established. There have been no reports of renewed price warfare among the Philadelphia dealers, although a few outlying stations handling unbranded products are selling for a half to a cent under the general market.

While the mild weather is benefiting gasoline consumption it is depressing light fuel oils to the extent that price shading is reported more frequently. Kerosene was reported available in tankcars in the New York Harbor area at 4⅝ cents and some said a firm bid in one or two directions of 4½ cents might move some stocks. A majority of sellers, however, continue their quotations of 4¾ cents.

Depressed with kerosene, due to the dull demand, is No. 2 fuel oil, which was said last week to be available in tankcars at 4 cents and barge deliveries could be obtained at 3⅞ cents. As in the case of kerosene, however, the larger sellers continued their previous prices of 4¼ cents for No. 2 fuel oil. Acceleration of the demand for industrial fuel oils continues and some traders reported the primary market for these products had moved upward at least 2 cents on the Gulf Coast. Reports were heard in New York that refiners on the Gulf formerly delivering cargoes at 60 cents per barrel are now asking 62 cents, although the lower figure prevails at one or two refineries. Greater activity by manufacturers, railroads, steamships and large building heating are factors influencing heavy fuel oil markets. Bunker C fuel oil prices of 95 cents per barrel remain steady to firm.

One cargo of heavy fuel oil sold on the Gulf Coast last week for export at 63 cents per barrel and two cargoes were moved in domestic coastwise trade at 60 to 62 cents. After these sales most refiners on the Gulf expressed belief the market will move forward to 65 cents in the near future.

Tanker rates are still moving forward. One boat was chartered last week, according to New York marine circles, at 22 cents per barrel, for movement of fuel oil late this month or early in December. This reported price is about 3 cents higher than the last previous fixture. Movement of fuel oil by tankers and barges through the inland waterways, particularly up the Hudson River, has been exceptionally heavy during the past two weeks. The near closing date of the New York barge canal doubtless is responsible for the rush to place over-the-winter requirements in terminal storage to avoid the more expensive overland transportation. The movement indicates, however, that distributors are anticipating much heavier demand and that refinery stocks will be lighter, perhaps removing the pressure at primary markets to some extent.

The Gulf Coast gasoline market is following routine lines at the moment. There has been little activity in the spot export market during the past two weeks and much the same condition exists in the coastwise trade. Contract purchasers of gasoline are ordering liberally against their commitments as the retail volume continues at a high level.

Spot gasoline prices on the Gulf Coast are about unchanged from 4½ cents for 60-octane and 4¾ cents for 65-octane grade. Gulf refiners are quoting about 3½ cents for No. 2 fuel oil and export gas oil. Makers of gas oil with higher Diesel index are asking from an eighth to a quarter of a cent higher prices.

Most products moved in the western Pennsylvania refinery district last week at unchanged prices. Some refiners dropped their third-grade gasoline prices a quarter of a cent to 4¾ in an effort to compete with straightrun motor fuel from Michigan appearing in the Ohio territory. Better grades of motor fuel were selling at unchanged prices, according to a majority of reports, although some said a few sources were offering leaded gasoline at slightly lower figures.

Pennsylvania Grade lubricating oils are practically unchanged. Improved demand for industrial lubricating oils and normal export movement are aiding in maintaining the firm tone of this market. Some reports were heard that slightly lower prices were quoted by one or two suppliers of bright stock. Neutral oils are unchanged with the 200-viscosity grade, 25 pour test, quoted at 16 cents and the zero pour test at 19 cents.

Cylinder oils range from 8 cents for the 600 steam refined, filterable, grade to 13 cents for the 630 flash. Bright stocks range from 14 to 17 cents, depending on the pourtest specification.

Indications are that wax is reasonably abundant at prices ranging from 2.3 to 2.4 cents per barrel. Some refiners are sold up on their production for the remainder of the year, but inquiries appear to bring adequate response. Export movement appears to be unchanged with shippers reporting normal buying on the part of foreign customers.

While the margin by which current gasoline stocks are below those of 1937 is not large, the trend in this direction is pointed to by eastern oil executives as showing the way for more favorable conditions in 1939, if it can be maintained. The drive for new car sales

(Continued on Page 264)

A. P. I. Weekly Refinery Statistics

Week Ending November 12, 1938

	Capacity reporting (per cent)	Daily crude runs (bbls.)	Total gasoline stocks	Gas oil and fuel oil stocks
East Coast	100.0	497,000	16,934,000	16,846,000
Appalachian	85.9	104,000	2,860,000	823,000
Indiana, Illinois, and Kentucky	89.5	462,000	10,245,000	9,214,000
Oklahoma, Kansas, and Missouri	81.6	241,000	6,126,000	4,694,000
Inland Texas	50.3	118,000	1,637,000	1,991,000
Texas Gulf	88.9	727,000	9,415,000	14,828,000
Louisiana Gulf	97.3	125,000	1,983,000	2,887,000
North Louisiana and Arkansas	55.0	51,000	470,000	879,000
Rocky Mountains	54.2	40,000	1,075,000	788,000
California	90.0	483,000	13,176,000	98,296,000
Total reported	85.6	2,848,000	63,921,000	151,246,000
Estimated unreported	.....	332,000	3,630,000	3,420,000
*Estimated total	.....	3,180,000	67,551,000	154,666,000
*Estimated total previous week	.....	3,160,000	68,236,000	154,576,000
*November 13, 1937	.....	3,335,000	69,073,000	120,201,000

*Bureau of Mines, currently estimated.

Stocks of Crude Oil in the United States

(BUREAU OF MINES ESTIMATES)

Week ending October 29, 1938	275,824,000 barrels
Week ending October 22, 1938	276,652,000 barrels
Week ending October 30, 1937	307,140,000 barrels

Figures do not include stocks of heavy, refinable California crude.

Retail Oil Markets

Tank-wagon and filling station prices on gasoline and kerosene furnished by the larger marketing firms

Prices as of November 15, 1938

Taxes

The gasoline quotations given in the following tables include the 1-cent federal tax, as well as state, county and city taxes. The gasoline is the regular or standard grade. In most areas lower grades and a premium grade also are available.

Standard Oil Co. (Indiana)

	Gasoline—Tank wag.	Dlr.	Inc. tax	Kero. tank-wag.
Chicago, Ill.	15.1	12.6	4.0	10.0
Decatur	15.1	12.6	4.0	10.0
Joliet	15.1	13.6	4.0	10.0
Peoria	15.1	13.1	4.0	10.0
Quincy	14.9	12.9	4.0	9.8
Davenport, Ia.	15.1	13.6	4.0	‡10.0
Des Moines	14.9	13.4	4.0	‡9.8
Mason City	15.3	13.8	4.0	‡10.2
Duluth, Minn.	16.9	15.4	5.0	10.8
Mankato	16.5	15.0	5.0	10.4
Minneapolis	16.5	14.5	5.0	10.4
LaCrosse, Wis.	16.5	15.0	5.0	10.4
Green Bay	16.9	15.4	5.0	10.3
Milwaukee	16.3	14.8	5.0	10.2
Detroit, Mich.	14.3	12.8	4.0	9.0
Grand Rapids	14.8	13.05	4.0	9.7
Saginaw	15.8	14.3	4.0	9.3
Evansville, Ind.	16.6	15.1	5.0	†10.5
Indianapolis	16.8	15.3	5.0	†9.5
South Bend	17.1	15.6	5.0	†9.0
Fargo, N. Dak.	16.7	15.2	4.0	11.6
Minot	18.0	16.5	4.0	12.9
Huron, S. Dak.	17.0	15.5	5.0	10.9
Kans. City, Mo.*	14.4	12.9	4.0	7.5
St. Louis*	14.7	13.2	4.0	9.6
St. Joseph	14.4	12.9	4.0	9.3
Wichita, Kans.	13.9	10.6	4.0	7.8

*State tax 2 cents, 1-cent city tax and 1-cent federal tax. †Does not include 4-cent state tax. ‡Does not include 3-cent state tax.

Exclusive of state general sales taxes.

Discounts to commercial consumers: On purchases per month off tank-wagon prices: 1,000 gallons or more, 1.5 cents off; minimum delivery 25 gallons.

Stanolex Fuel Oil in Chicago

Effective November 1, 1938, f.o.b. Chicago tank-wagon prices: Standard range oil, 1-99 gallons, 9 cents; 100-149 gallons, 8 cents; 150 gallons and over, 7.5 cents. Stanolex fuel oil No. 1, 1-149 gallons, 8 cents; 150-399 gallons, 7 cents; 400 gallons and over, 6.5 cents. Stanolex furnace oil, 1-149 gallons, 8 cents; 150-399 gallons, 7 cents; 400 gallons and over, 6.5 cents. Stanolex grade A, 1-399 gallons 4.75 cents; 400 gallons and over 3.75 cents. Stanolex grade B, 1-799 gallons, 4.75 cents; 800 gallons and over, 3.75 cents.

Atlantic Coast District

STANDARD OIL CO. OF NEW JERSEY

	Gasoline—Tank-wag. dlr.	Tank-car con'r.	Inc. tax	Kero tank wag.
Atl'tic City, N. J.	12.9	10.9	4.0	8.0
Newark	12.9	10.9	4.0	8.0
Annapolis, Md.	14.35	12.85	5.0	9.5
Baltimore	13.75	12.25	5.0	8.5
Cumberland	16.15	13.65	5.0	10.0
Wash'g'n, D. C.	12.0	10.50	3.0	9.5
Danville, Va.	16.95	14.45	6.0	12.9
Norfolk	15.75	13.25	6.0	11.5
Petersburg	16.05	13.55	6.0	11.7
Richmond	16.05	13.55	6.0	11.7
Roanoke	17.25	14.75	6.0	11.0
Charles'n, W. V.	16.55	14.05	6.0	12.6
Parkersburg	14.85	13.35	6.0	11.2
Wheeling	15.75	14.35	6.0	12.2
Charlotte, N. C.	18.15	15.65	7.0	12.1
Hickory	18.65	16.15	7.0	12.5
Mt. Airy	18.45	15.95	7.0	12.3
Raleigh	17.75	15.25	7.0	11.6
Salisbury	18.25	15.75	7.0	12.2
Charleston, S. C.	16.75	14.25	7.0	10.6
Columbia	17.75	15.25	7.0	11.6
Spartanburg	18.45	15.95	7.0	12.4

Price basis to commercial consumers, effective March 8, 1937, in Maryland, District of Columbia, and in Arlington and Fairfax counties in Virginia; and March 12 in New Jersey: To contract accounts purchasing at least one full compartment at time by hose connection, on yearly purchases: From 2,500 to 100,000 gallons, consumer tank-wagon price at time and place of delivery; 100,000 gallons per year, consumer tankcar price plus .5 cent per gallon. Consumer tank-wagon price generally will be equivalent to dealer tank-wagon price less .5 cent per gallon.

Effective May 15, 1937, in North and South Carolina, West Virginia and Virginia (except Arlington and Fairfax counties): Commercial consumers taking deliveries of 50 gallons (W. Va., 100 gallons) or more at one time will be billed at posted consumer tank-wagon price. Accounts taking deliveries of less than 50 gallons (W. Va., 100 gallons) will be billed at 4 cents per gallon over posted consumer tank-wagon price. Generally the posted consumer tank-wagon price will be the equivalent to the dealer price less .5 cent per gallon.

While the above prices continue at Atlantic City and Newark, N. J., dealers will pay a net price of 8.4 cents per gallon for Essolene. Dealers having pumps marked only "Esso, Essolene and 'Standard White'" gasoline will pay 7.9 cents for Essolene. Price basis to all other undivided dealers above is Essolene dealer tank-wagon price less .5 cent per gallon.

Discount for kerosene, 1 cent off tank-wagon price for 25 gallons or more under contract (contract not necessary in Baltimore) except no discount in New Jersey.

Southern District

STANDARD OIL CO. (KENTUCKY)

	Gasoline—Tank-wag.	Net dlr.	Inc. tax	Kero. tank-wag.
Atlanta, Ga.	20.5	17.5	7.0	10.0
Augusta	20.0	17.0	7.0	10.0
Macon	20.0	17.0	7.0	11.0
Savannah	19.0	16.0	7.0	9.0
Birm'ham, Ala.	21.0	18.0	8.0	9.5
Mobile	21.0	18.0	9.0	8.5
Montgomery	21.0	19.0	9.0	10.5
Jackson, Miss.	19.5	16.5	7.0	9.5
Vicksburg	19.5	16.5	7.0	9.0
Jacksonville, Fla.	20.0	17.0	8.0	8.0
Miami	20.0	17.0	8.0	8.0
Pensacola	21.0	18.0	9.0	8.0
Tampa	20.0	17.0	8.0	8.0
Lexington, Ky.	19.5	16.5	6.0	10.0
Covington	18.0	15.0	6.0	9.5
Louisville	17.5	14.5	6.0	9.0
Paducah	18.0	15.0	6.0	9.0

*Includes 1-cent state tax.

Price basis to tank-wagon consumers: Effective January 4, 1937; 3 cents per gallon below tank-wagon price. Effective June 4, 1938, 2 cents per gallons discount eliminated from all kerosene markets in Mississippi, Alabama, Georgia, and Florida, markets being reduced correspondingly to a net basis.

Montgomery, Ala., has a county tax of 1 cent per gallon, and a city tax of 1 cent per gallon on gasoline, in addition to state tax; and 1 cent per gallon on kerosene. Mobile, Ala., has a city gasoline tax of 2 cents per gallon; Birmingham, Ala., has a city gasoline tax of 1 cent per gallon; Pensacola, Fla., has a city gasoline tax of 1 cent.

Rocky Mountain District

CONTINENTAL OIL CO.

	Gasoline—Dealer	Inc. tax	Kero. tank-wag.
Denver, Colo.	15.5	5.0	11.5
Grand Junction	19.0	5.0	15.0
Pueblo	16.5	5.0	10.5
Casper, Wyo.	17.0	5.0	11.5
Cheyenne	13.0	5.0	13.0
Billings, Mont.	19.0	6.0	13.0
Butte	19.5	6.0	15.5
Helena	20.0	6.0	15.5
Great Falls	19.0	6.0	15.5
Salt Lake City, Utah	17.0	5.0	16.0
Twin Falls, Idaho	21.0	6.0	18.0
Boise	19.0	6.0	18.0
Albuquerque, N. M.	17.5	*6.5	12.0

*Includes city tax of .5 cent.

Ohio

STANDARD OIL CO. OF OHIO

	Gasoline—Tank-wag. con'r.	Divided dlr.	Inc. tax	Kero. tank-wag.
Ohio points	16.0	15.0	5.0	*13.0

*Includes state tax of 1 cent.

Pacific Coast Territory

STANDARD OIL CO. OF CALIFORNIA

	Gasoline—Tank-wag.	Serv. sta.	Inc. tax.	Kero. tank-wag.
San Francisco	17.5	18.5	4.0	11.5
Los Angeles	17.0	18.0	4.0	10.0
Fresno, Calif.	18.5	19.5	4.0	12.5
Phoenix, Ariz.	21.5	22.5	6.0	*17.5
Reno, Nev.	20.5	21.5	5.0	13.5
Portland, Ore.	20.0	21.0	6.0	13.5
Seattle, Wash.	20.0	21.0	6.0	13.5
Spokane	23.0	24.0	6.0	16.5
Tacoma	20.0	21.0	6.0	13.5

*Includes 5-cent state tax.

Discounts to dealers: On gasoline, off tank-wagon price, to 100 per cent dealers, 3 cents; to split dealers, 2 cents. To commercial consumers: on tank-wagon price: on single deliveries of 40 gallons and over, advance quantity discount extended at time of delivery, 3 cents. Service station schedule applies on single deliveries less than 40 gallons. On kerosene in tankcar, transport truck and trailer delivery, 3 cents off tank-wagon price; plant deliveries to jobbers, 2.5 cents below tank-wagon.

New York and New England

SOCONY-VACUUM OIL CO., INC.

	Gasoline—T'wag. dealer	T'car consr.	Inc. tax	Kero. tank wag.
Albany	14.3	12.3	5.0	8.0
*Met. N. Y.:				
Manhat., Bronx	13.4	12.25	5.0	8.0
Staten Island	13.4	12.25	5.0	8.0
Q'ns. & Bklyn.	13.4	12.25	5.0	8.0
Buffalo	12.9	12.6	5.0	7.5
Rochester	14.0	13.2	5.0	8.5
Syracuse	14.0	12.9	5.0	9.0
Boston, Mass.	12.5	11.0	4.0	7.5
Portland, Me.	14.0	12.25	5.0	8.75
Manch'ter, N. H.	14.5	12.8	5.0	8.5
Burlington, Vt.	14.7	12.65	5.0	9.5
Springf'd., Mass.	13.0	11.5	4.0	8.0
Worcester	13.0	11.5	4.0	8.0
Hartford, Conn.	13.0	11.4	4.0	7.0
New Haven	12.8	11.3	4.0	6.0
Providence, R. I.	12.5	11.0	4.0	7.5

*Does not include 2 per cent city sales tax which is calculated on basis of net retail price exclusive of state and federal taxes. Metropolitan New York prices are undivided dealer prices; others are split dealer.

Price basis to undivided dealer: Posted dealer tank-wagon price less .5 cent. Price basis to commercial consumer: Effective Nov. 15, 1936, monthly purchases of 25,000 gallons and over, consumer tankcar prices at delivery point plus .5 cent per gallon; monthly purchases of 5,000 to 25,000 gallons, undivided dealer price at delivery point; monthly purchases under 5,000 gallons, pay divided dealer tank-wagon prices at delivery point.

Pennsylvania, Delaware and Part of New England

ATLANTIC REFINING CO.

	Gasoline—Tank-wag. dlr.	Tank-car con'r.	Inc. tax	Kero. tank-wag.
Phil'delphia, Pa.	13.0	12.0	5.0	10.0
Pittsburgh	15.0	13.0	5.0	10.5
Allentown	14.25	12.75	5.0	10.5
Erie	14.5	13.0	5.0	10.0
Scranton	14.5	13.0	5.0	10.5
Altoona	15.0	13.0	5.0	10.5
Dover, Del.	13.5	....	5.0	10.5
Wilmington	†2.5	....	5.0	9.75

Price basis to undivided dealers, dealer tank-wagon price less .5 cent per gallon. Price basis to commercial consumers in Pennsylvania and Delaware, effective March 11, 1937: Consumers under contract using 100,000 gallons or more per year full compartment hose deliveries, tankcar plus .5 cent. Consumers under contract using less than 100,000 gallons per year compartment hose deliveries, undivided dealer price. Consumers under contract less than full compartment delivery, consumers not under contract, less than full compartment delivery, and consumers not under contract full compartment delivery, divided dealer price. Less than 25 gallons, tank-wagon delivery, 4 cents per gallon above undivided dealer price.

Central South District

STANDARD OIL CO. OF LOUISIANA

	Gasoline—Tank-wag. dlr.	Tank-car con'r.	Inc. tax	Kero-tank-wag.
N. Orleans, La.	19.25	16.75	*10.0	†11.0
Baton Rouge	17.25	14.75	8.0	‡10.5
Alexandria	17.25	14.75	8.0	‡12.5
Lafayette	17.50	15.00	8.0	‡12.5
Lake Charles	17.25	14.75	8.0	‡12.5
Shreveport	16.00	13.50	8.0	‡11.0
Knoxville, Tenn.	20.50	18.00	8.0	14.5
Memphis	18.50	16.00	8.0	12.5
Chattanooga	20.00	17.50	8.0	14.0
Nashville	17.50	17.00	8.0	12.0
Bristol	19.00	18.25	8.0	14.5

*Includes 2-cent parish tax. †Includes 1-cent parish tax and 1-cent state tax. ‡Includes 1-cent state tax.

Price basis to commercial consumers: Effective May 15, 1937, deliveries of 50 gallons or more in one delivery takes posted consumer tank-wagon price. Accounts taking deliveries of less than 50 gallons at one time pay posted consumer tank-wagon price plus 4 cents per gallon. Generally, the posted consumer tank-wagon price will be equivalent to the dealer price less .5 cent per gallon. Kerosene prices include 1-cent state tax.

Nebraska

STANDARD OIL CO. OF NEBRASKA

	Gasoline—Tank-wag.	Dlr.	Inc. tax	Kero. tank-wag.
Omaha	17.5	16.0	6.0	10.3
McCook	17.5	16.0	6.0	10.0
Norfolk	17.9	14.9	6.0	10.7
North Platte	18.3	15.4	6.0	11.0
Scottsbluff	19.0	13.9	6.0	11.8

Discounts to commercial consumers for tank-wagon deliveries covered only by standard commercial consumers contract, effective Jan. 1, 1935

Oklahoma and Arkansas

CONTINENTAL OIL CO

	Gasoline—Dealer	Inc. tax	Kero. tank-wag.
Muskogee, Okla.	14.5	5.0	7.0
Oklahoma City	13.5	5.0	7.0
Tulsa	12.0	5.0	6.0
Fort Smith, Ark.	14.25	5.0	7.5
Little Rock	16.75	7.5	8.0
Texarkana	14.0	5.0	8.0

Texas

	Gasoline—Tank-wag.	Serv. sta.	Inc. tax.	Kero. tank-wag.
Dallas, Tex.	14.0	17.0	5.0	8.0
Fort Worth	15.0	19.0	5.0	8.0
Houston	14.5	19.0	5.0	8.0
San Antonio	14.0	18.0	5.0	8.0

Naphtha

STANDARD OIL CO. (INDIANA)

	Tank-wagon*
Oleum spirits	15.7
V.M.&P. naphtha	16.0
Cleaners' naphtha	15.0
Stanisol	15.0

*Prices include 3-cent Illinois tax, but not 1-cent federal tax or 2 per cent retail occupational tax.

Prices f.o.b. Chicago. Each price subject to discount of 1 cent per gallon for 150-gallon lots if covered by contract.

Canada*

3-Star Imperial Gasoline
IMPERIAL OIL, LTD.

	Tank-wag.	Inc. tax	Kero. tank-wag.
Halifax, N. S.	23.5	10.0	17.5
St. John, N. B.	23.5	10.0	17.5
Monteral, Que.	20.0	6.0	14.5
Toronto, Ont.	21.0	6.0	15.5
Hamilton, Ont.	21.0	6.0	15.5
Winnipeg, Man.	27.5	7.0	20.7
Brandon, Man.	28.1	7.0	22.9
Regina, Sask.	26.0	7.0	22.0
Saskatoon, Sask.	28.3	7.0	24.9
Edmonton, Alta.	26.5	7.0	21.5
Calgary, Alta.	23.5	7.0	19.0
Vancouver, B. C.	23.0	7.0	23.0

*Imperial gallon used in Canada.

Divided dealers pay tank-wagon prices. Discount to undivided dealers, 1 cent below tank-wagon price. In maritime provinces both divided and undivided dealers pay tank-wagon price.

Tank-Wagon Changes

Standard Oil Co. of Louisiana November 2 reduced dealer tank-wagon gasoline 2 cents in Nashville.

Standard Oil Co. (Indiana) November 5 reduced dealer gasoline .5 cent in Peoria.

Socony-Vacuum Oil Co., Inc., November 10 reduced tank-wagon gasoline to divided dealers .5 cent in Binghampton, N. Y., making the new price 9½ cents, exclusive of taxes.

New York Market

(Continued from Page 263)

reached its peak last week when the New York automobile show opened and will continue well into 1939. The extent to which the automobile industry fulfills its planned program of producing and selling from 3,125,000 to 3,250,000 units of the 1939 models is linked closely with the predictions of a 3 to 5 per cent increase in motor fuel consumption for next year. Refiners are showing an inclination to view the forecasts with more than usual caution and a majority would like to see motor fuel stocks not above 70,000,000 bbls. on January 1.

Prices of Refined Products

All quotations f.o.b. plant in cars for interstate or export movement except as otherwise noted

Prices as of November 15, 1938

The following quotations are exclusive of the federal excise taxes of 1 cent a gallon on gasoline and 4 cents a gallon on lubricating oils.

Refinery Gasoline

OKLAHOMA (Group 3)—

U. S. Motor grades:		
62 oct. and below	.03¾	.04
63-66 octane	.04	.04¼
67-69 octane	.04⅜	.04⅝
70-72 octane (regular)	.04⅝	.04⅞
60-62 400 grades:		
62 oct. and below	.03¾	.04
63-66 octane	.04	.04¼
67-69 octane	.04⅜	.04⅝
70-72 octane (regular)	.04⅝	.04⅞
64-66 375	.04	.04¼
68-70 360	.05	.05¼

NORTH TEXAS—

U. S. Motor grades:		
62 octane and below	.03¾	.04
63-66 octane	.04	.04¼
67-69 octane	.04⅜	.04⅝
70-72 octane (regular)	.04⅝	.04⅞
60-62 400	.03¾	.04
64-66 375	.04	.04¼

NORTH LOUISIANA (Ark. and N. La. delivery)—

U. S. Motor grades:		
62 octane and below	.04⅜	.04½
63-66 octane	.04½	.04⅝
67-69 octane	.04⅝	.04⅞
70-72 octane (regular)	.05¼	.05½

ARKANSAS (Ark. and N. La. del.)—

U. S. Motor grades:		
62 octane and below	.04¼	.04⅜
67-69 octane	.05	.05⅛

CHICAGO (Based on Group 3)—

U. S. Motor grades:		
62 octane and below	.03¾	.04
63-66 octane	.04	.04¼
67-69 octane	.04⅜	.04⅝
70-72 octane	.04⅝	.04⅞
60-62 400 grades:		
62 octane and below	.03¾	.04
63-66 octane	.04	.04¼
67-69 octane	.04⅜	.04⅝
70-72 octane	.04⅝	.04⅞
64-66 375	.04	.04¼
68-70 360	.05	.05¼

PENNSYLVANIA (inland refineries)—

58-60 U. S. Motor:		
Below 60 octane	.04¾	.05¼
65 octane		.06¼
68-70 octane		.06¾

CALIFORNIA (domestic movement)—

54-58 U. S. Motor	.06½	.08
58-60 400, 65 oct. and higher	.07½	.09

EAST COAST (domestic)—

U. S. Motor, 60-64.9 octane:		
New York (Bayonne)	.06	.06¼
Philadelphia	.06	.06¼
Boston	.06¼	.06½
Baltimore	.06	.06¼
Charleston, S. C.	.06¾	.07
U. S. Motor, 65 and above:		
*New York (Bayonne)	.06½	.06¾
Philadelphia	.06½	.06¾
Boston	.06½	.06¾
Baltimore	.06½	.06¾
Charleston, S. C.	.07	.07¼

*All grades of gasoline one-eighth to one-fourth cent less for barge shipments. New York Harbor prices are for New York and New England delivery. Prices for New Jersey delivery one-fourth cent lower.

GULF COAST (domestic)—

U. S. Motor grades:		
Below 60 octane		.04½
60-64.9	.04½	.04⅝
65 octane and higher	.04⅝	.04¾
68-70	.05	.05⅛

Naphtha

PENNSYLVANIA (inland refineries)—

52-56 450 (blending)	.04¾	.04⅞

Natural Gasoline

OKLAHOMA (Group 3)—

Grade 26-70		.03
Grade 18-55	.03½	.03⅝

NORTH TEXAS—

Grade 26-70	.02¾	.03
Grade 18-55		.03¼

CALIFORNIA—

75-85 375-390	.06¼	.07

NORTH LOUISIANA (Ark. and N. La. delivery)—

Grade 26-70		.03⅛

Tractor Fuel

OKLAHOMA (Group 3)—

40-42 gr., 315-325 l.b.p., 110-flash, 540-550 e.p.	.03⅞	.04
41-43 gr., 300-320 l.b.p., 110-125 flash, 500-520 e.p.	.04⅛	.04¼
46-48 gr., 210-230 l.b.p., 480 max., e.p.	.04½	.04¾

Kerosene

(All kerosene water white)

OKLAHOMA (Group 3)—

41-43	.04	.04⅛
42-44	.04¼	.04⅜

NORTH TEXAS—

41-43	.04	.04⅛

NORTH LOUISIANA (Ark. and N. La. delivery)—

41-43	.04	.04⅜

ARKANSAS (Ark. and N. La. del.)—

41-43	.04½	.04⅝

PENNSYLVANIA (inland refineries)—

45	.04¾	.05
46	.04⅞	.05⅛
47	.05	.05⅛

CHICAGO (Based on Group 3)—

41-43	.04	.04⅛
42-44	.04¼	.04⅜

CALIFORNIA (Pac. Coast market)—

38-43 high burning test	.04¾	.05¾

NEW YORK (Bayonne, N. J.)—

41-43	.04⅝	.04¾

***GULF COAST (domestic)—**

41-43	.03⅞	.04⅛

*Barge price one-eighth cent lower.

Furnace Oil

OKLAHOMA (Group 3)—

Range oil	.03⅞	.04
No. 1 prime white, 38-42	.03¾	.03⅞
No. 1 straw, 38-40	.03⅝	.03⅞
No. 2 straw, 32-36	.03½	.03¾
No. 2 dark, 32-36	.03⅝	.03½
No. 3 zero to 15, 28-32	.03¼	.03⅜
No. 3, 15 and above, 28-32	.02⅞	.03

NORTH TEXAS—

No. 1 prime white 38-42	.03¾	.03⅞
No. 1 straw, 38-40	.03⅝	.03⅞

NORTH LOUISIANA (Ark. and N. La. delivery)—

No. 2, 32-36	.03¼	.03½

ARKANSAS (Ark. and N. La. del.)—

No. 2, 32-36		.03⅝

CHICAGO (Based on Group 3)—

Range oil	.03⅞	.04⅛
No. 1 prime white, 38-40	.03¾	.04
No. 1 straw, 38-40	.03⅝	.03⅞
No. 2 straw, 32-36	.03½	.03¾
No. 2 dark, 32-36	.03¼	.03½
No. 3, zero to 15, 28-32	.03¼	.03⅜
No. 3, 15 and above, 28-32	.02⅞	.03

NEW YORK (Bayonne, N. J.)—

*No. 1	.04½	.04⅝
*No. 2		.04
*No. 4		.04

*Barge deliveries one-eighth to one-fourth cent under above tankcar price.

Gas Oil and Fuel Oil

(Gas oil per gal.; fuel oil per bbl.)

OKLAHOMA (Group 3)—

U.G.I. gas oil	.02⅞	.03⅛
No. 4, low pourpoint, 24-28	1.00	1.10
No. 4, 15 and above, 24-28	.85	.90
No. 5, low pourpoint, 18-22	.70	.75
Below 18 fuel oil, industrial	.50	.60

NORTH TEXAS—

U.G.I. gas oil	.02⅞	.03⅛
No. 4, low pourpoint, 24-28	1.00	1.10
No. 5, low pourpoint, 18-22	.70	.75
Below 18 fuel oil, industrial	.50	.60

NORTH LOUISIANA (Ark. and N. La. delivery)—

10-14 fuel oil, industrial	.70	.75

CHICAGO (Based on Group 3)—

U.G.I. gas oil	.02⅞	.03
No. 4, low pourpoint, 24-28	1.00	1.10
No. 4, 15 and above, 24-28	.85	.95
No. 5, low pourpoint, 18-22	.70	.80
No. 5, 15 and above, 18-22	.60	.70
No. 6, low pourpoint, 10-16	.60	.70
No. 6, 15 and above, 10-16	.35	.45

PENNSYLVANIA (inland refineries)—

36-40	.03⅞	.04⅝

CALIFORNIA—

Los Angeles:		
30-40 gas oil, per bbl.	1.15	1.35
24 plus Diesel, per bbl.	1.00	1.30
24 plus Diesel (bunkers)	1.25	1.50
12-16 (bunkers at tidewater)	.80	.90
10-16 (cargo lots)	.65	.85
12-17 (tankcars)	.50	.85
10-17 (high sulfur)	.45	.70
San Joaquin Valley:		
10-18 (tankcars)	.55	.85
24 plus Diesel, per bbl.	1.20	1.45
San Francisco:		
24 plus Diesel, per bbl.	1.40	1.45
24 plus Diesel (bunkers)	1.45	1.55
10-16 (bunkers)	.90	.95

GULF COAST—

No. 2 fuel		.03⅜
43-47 Diesel		.03½
48-52 Diesel	.03½	.03⅝
53-57 Diesel	.03⅝	.03¾
Bunkers (bulk cargoes)	.60	.65
Bunker C (bunkers)		.75

NEW YORK (Bayonne, N. J.)—

27 plus, gas oil		.04¼
28-30 Diesel (lighterage 6¼c per bbl.)		1.75
28-30 Diesel (tankcars)	.04¼	.04½
Bunker C (to ocean-going ships in N. Y. Harbor)		.95
Industrial fuel (tankcars)	.03¾	.04

Lighterage charge 5c bbl. additional.

Bright and Steam Refined

OKLAHOMA (Group 3)—

190-200 D, 15-25		.19
150-160 D, 0-10	.14¼	.16
150-160 D, 15-25	.13½	.15½
150-160 E, 15-25	.13	.15
100-110 D, 0-10		.14½
Steam refined:		
631 green (treated)		.12½
600 dark green (untreated)	.04½	.05

PENNSYLVANIA—

Bright Stocks (Pennsylvania Grade No. 8 color, 140-150 at 210, 545-550 flash):		
10 pourpoint	.17	.17½
15 pourpoint	.16	.16½
20 pourpoint	.15	.15½
25 pourpoint	.14	.14½
Steam refined:		
600	.08	.08½
650	.10	.10½
600 Pennsylvania flash	.10½	.11
630 flash	.13½	.14
600 Warren E filtered	.12½	.13

Neutral Oil

(Vis. at 100° F. except Pennsylvania and color N.G.A.)

OKLAHOMA (Group 3)—

150-3	.09
180-3	.10
180-4	.09½
200-3	.10½
200-4	.10
250-3	.11½
250-4	.11
280-3	.12½
280-4	.12
300-6½	.13
400-3½	.14
100-2½ paraffin oil	.06
15-20 pourpoint:	
200-3	.10
200-4	.09½
250-3	.11
250-4	.10½
280-3	.12
280-4	.12½

GULF COAST—

Pale oils:		
200-3	.07	.07¼
300-3	.07½	.07¾
500-3½	.08½	.08¾
750-3½	.08⅝	.09¼
1,200-3½	.09½	.09¾
1,500-4	.09¾	.10
Red oils:		
200-5-6	.07¼	.07½
300-5-6	.07¼	.07½
500-5-6	.08	.08½
750	.08¾	.09
1,200-5-6	.09¼	.09½

CALIFORNIA (moving to dom. market)—

Pale oils:		
100-2½-3	.07¼	.08
200-2½-3	.07¼	.08
300-2½-3	.07¼	.08
400-3-4	.07¼	.08
450-3-4	.07¼	.08
550-3-4	.09	.11
600-3-4	.09	.11
Red oils:		
200-4-5	.07¼	.08
300-5-6	.07¼	.08
350-5-6	.09¼	.11½
400-5-6	.09¼	.11½
450-5-6	.09¼	.11½
500-5-6	.09¼	.11½
600-5-6½	.09¼	.11½
700-6½ plus	.09¼	.11½
750-6½ plus	.09¼	.11½
900-6½ plus	.09¼	.11½

PENNSYLVANIA—

150 vis. at 70° color, 400-405 flash:		
Zero pourpoint	.17	.17½
10 pourpoint	.16	.16½
15 pourpoint	.15	.15½
25 pourpoint	.14	.14½
200 vis. at 70° F., 3 color:		
Zero pourpoint	.19	.19½
10 pourpoint	.18	.18½
15 pourpoint	.17	.17½
25 pourpoint	.16	.16½

Wax and Petrolatum

(Prices per pound)

OKLAHOMA (Group 3)—

124-126 (a.m.p.) w.c. scale	.02¼	.02½

PENNSYLVANIA (inland refineries)—

122-124 (a.m.p.) w.c. scale	.0235	.0245
124-126 (a.m.p.) w.c. scale	.0235	.0245

NEW YORK—

Wax in bags fully refined:	
122-125 (a.m.p.) wax	.0375
125-127 (a.m.p.) wax	.0390
128-130 (a.m.p.) wax	.0400
130-132 (a.m.p.) wax	.0435
133-135 (a.m.p.) wax	.0465
135-137 (a.m.p.) wax	.0490
124-126 (a.m.p.) w.s.	.0230
124-126 (a.m.p.) y.s.	.0230
Petrolatum in barrels, carload lots:	
Dark green	.02 .02½
Amber	.02¾ .02½
Extra amber	.02⅝ .02¾
Lily white	.05¼ .05½
Snow white	.06¼ .06½
Cream	.04¼ .04½

Export Prices

GASOLINE

GULF COAST—

U. S. Motor	.04⅝	.04¾
60-62 400	.04⅝	.04¾
61-63 390	.04⅝	.05
64-66 375	.04⅝	.05

LOS ANGELES—

U. S. Motor grades:		
55-65 octane		.05
65-69 octane		.05¼
Above 69 octane		.05½

KEROSENE

GULF COAST—

41-43 prime white		.04
41-43 water white		.04

LOS ANGELES—

41-43 water white	.05	.05¼

LUBRICANTS

(Pennsylvania Grade)

NEW YORK (l.a.s. in bbls.)—

Cylinder stocks:		
600 Warren E	.15	.15½
600 S.R. unfiltered	.16	.16½
630 S.R. unfiltered	.17	.17½
600 flash, S.R.	.17	.17½
630 flash, S.R.	.20½	.21
Bright stock:		
8 color	.16¼	.16½

NEUTRAL OIL

200-3 color	.21½	.22
150-3 color	.19½	.20

PARAFFIN WAX

NEW YORK (prices per pound)—

123-125 a.m.p.		.0375
125-127 a.m.p.		.0387
128-130 a.m.p.		.0412
133-135 a.m.p.		.0437
135-137 a.m.p.		.0455
Crude scale:		
124-126 w.s.	.0185	.0200
124-126 y.s.	.0185	.0200

Crude Oil Prices

Oklahoma, Kansas, North Central and East Central Texas

East Texas (Oct. 11, 1938)* $1.10
Van, Tex. (Oct. 11, 1938)* ..... .93
Talco, Tex. (Oct. 11, 1938)* ..... .55
Rodessa, Tex. .....
See North Louisiana gravity schedule

Cass and Panola counties, Texas
See gravity schedule
Altus and Tipton† .....See note below
Cayuga, Tex. (Oct. 12) ..... .81
Clay Creek, Tex. ..... .85

*Humble Oil & Refining Co. †Gulf Refining Co.

Altus and Tipton, Okla., starting at below 25 degrees at 71 cents, 2-cent spread to 40 degrees and above at $1.03. East Texas price met by all buyers posting prices. Talco price adopted by Talco Pipe Line on October 11. Cayuga posted by Tide Water Associated Oil Co. Clay Creek posted by Sun Oil Co.

Crude Prices by Gravities

	Oklahoma	Oklahoma and Kansas	North and Central Texas	Louisiana and Arkansas	East Central Texas	Gray County, Texas	Hutchinson and Carson counties, Texas	Raccoon Bend, Satsuma and Tomball, Texas	West Texas and Lea County, N. M.	Fort Collins and Wellington, Colo.	Anahuac and Dickinson, Texas	Refugio, Texas	Mirando and Duval Texas	Gulf Coast Texas	Cass and Panola counties, Texas	Beaumont and West Beaumont, Texas	Lockport, Iowa, Cameron Meadows, Louisiana	Artesia, Jackson and Maljamar, N. M.	Iowa, Louisiana
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Below 18	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	$.74	....	$.75
18-18.9	....	....	....	....	....	....	....	....	$.53	....	$.74	$.79	$.74	$.79	....	....	.76	....	.77
19-19.9	....	....	....	....	....	....	....	....	.53	....	.74	.79	.74	.79	....	$.79	.78	....	.79
20-20.9	$.60	$.70	....	....	....	....	....	....	.55	....	.77	.82	.77	.82	....	.82	.80	....	.81
21-21.9	.63	.72	....	....	....	....	....	....	.57	....	.80	.85	.80	.85	....	.85	.82	....	.83
22-22.9	.66	.74	....	....	....	....	....	$.95	.59	....	.83	.88	.83	.88	....	.88	.85	....	.86
23-23.9	.69	.76	....	....	$.78	....	....	.97	.61	....	.86	.91	.86	.91	....	.91	.88	....	.89
24-24.9	.72	.78	$.71	....	.80	....	....	.99	.63	....	.89	.94	.89	.94	....	.94	.91	....	.92
Below 25	....	....	....	$.73	....	....	....	....	....	....	....	....	....	....	$.73	....	....	....	....
25-25.9	.75	.80	.73	.75	.82	....	....	1.01	.65	....	.92	.97	.92	.97	.75	.97	.94	....	.95
26-26.9	.78	.82	.75	.77	.84	....	....	1.03	.67	....	.95	1.00	.95	1.00	.77	1.00	.97	....	.98
27-27.9	.81	.84	.77	.79	.86	....	....	1.05	.69	....	.97	1.02	.97	1.02	.79	1.02	.99	....	1.00
28-28.9	.84	.86	.79	.81	.88	$.72	$.67	1.07	.71	$.81	.99	1.04	.99	1.04	.81	1.04	1.01	$.61	1.02
29-29.9	.87	.88	.81	.83	.90	.74	.69	1.09	.73	.83	1.01	1.06	1.01	1.06	.83	1.06	1.03	.63	1.04
Below 30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
30-30.9	.90	.90	.83	.85	.92	.76	.71	1.11	.75	.85	1.03	1.08	1.03	1.08	.85	1.08	1.05	.65	1.06
31-31.9	.92	.92	.85	.87	.94	.78	.73	1.13	.77	.87	1.05	1.10	1.05	1.10	.87	1.10	1.07	.67	1.08
32-32.9	.94	.94	.87	.89	.96	.80	.75	1.15	.79	.89	1.07	1.12	1.07	1.12	.89	1.12	1.09	.69	1.10
33-33.9	.96	.96	.89	.91	.98	.82	.77	1.17	.81	.91	1.09	1.14	1.09	1.14	.91	1.14	1.11	.71	1.12
34-34.9	.98	.98	.91	.93	1.00	.84	.79	1.19	.83	.93	1.11	1.16	1.11	1.16	.93	1.16	1.13	.73	1.14
Below 35	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
35-35.9	1.00	1.00	.93	.95	1.02	.86	.81	1.21	.85	.95	1.13	1.18	1.13	1.18	.95	1.18	....	.75	....
36-36.9	1.02	1.02	.95	.97	1.04	.88	.83	1.23	.87	.97	1.15	1.20	1.15	1.20	.97	1.20	....	.77	....
37-37.9	1.04	1.04	.97	.99	1.06	.90	.85	1.25	.89	.99	1.17	1.22	1.17	1.22	.99	1.22	....	.79	....
38-38.9	1.06	1.06	.99	1.01	1.08	.92	.87	1.27	.91	1.01	1.19	1.24	1.19	1.24	1.01	1.24	....	.81	....
39-39.9	1.08	1.08	1.01	1.03	1.10	.94	.89	1.29	.93	1.03	1.21	1.26	1.21	1.26	1.03	1.26	....	.83	....
40 and over	1.10	1.10	....	1.05	1.12	....	....	....	.95	1.05	....	....	....	1.28	1.05	1.28	....	.85	....
40-40.9	....	....	1.03	....	....	.96	.91	1.31	....	....	1.23	1.28	1.23	....	....	....	....	....	....
41-41.9	....	....	1.05	....	....	.98	.93	1.33	....	....	1.25	1.30	1.25	....	....	....	....	....	....
42-42.9	....	....	1.07	....	....	1.00	.95	1.35	....	....	1.27	1.32	1.27	....	....	....	....	....	....
43-43.9	....	....	1.09	....	....	1.02	.97	1.37	....	....	1.29	1.34	1.29	....	....	....	....	....	....
44-44.9	....	....	1.11	....	....	1.04	.99	1.39	....	....	1.31	1.36	1.31	....	....	....	....	....	....
45 and over	....	....	1.13	....	....	1.06	1.01	1.41	....	....	1.33	1.38	1.33	....	....	....	....	....	....

Column 1—Magnolia Petroleum Co., effective October 12, 1938. Shell Petroleum Corp., effective October 22, 1938, in Oklahoma and Kansas; Mid-Continent Petroleum Corp., in Oklahoma, starting at 21 degrees at 63 cents, effective October 15, 1938.

Column 2—Standard Oil Co. of Indiana, effective October 11, 1938, below 29 degrees 86 cents, with 2-cent spread to 40 and over at $1.10. Same company on October 17 revised the schedule to start at below 21 degrees at 70 cents, with 2-cent spread to 40 and over at $1.10. Sinclair Prairie Oil Marketing Co. schedule started at below 25 degrees, 60 cents; 25-25.9, 80 cents with 2-cent differential up to $1.10 for 40 degrees and over, effective October 11, but was revised on October 14, starting at 21 gravity, 63 cents, with a 3-cent spread to 30-30.9 degrees at 90 cents, then a 2-cent spread to 40 degrees and over at $1.10. Gulf Oil Corp. schedule starts at below 25 degrees, 78 cents, with 2-cent differential up to $1.10 for 40 degrees and over, effective October 13. Shell Petroleum Corp. schedule same as that of Gulf, effective October 13 to October 21 (see Column 1). The Texas Co. schedule starts at 28-28.9 degrees, 86 cents, with top of $1.10 for 40 degrees and over. Pure Oil Co. same as Standard of Indiana's October 11 schedule, effective October 14.

Column 3—Humble Oil & Refining Co. in Central Texas, effective October 11. Magnolia Petroleum Co. schedule in North and Central Texas, same as the Humble, excepting that it starts at below 29 degrees at 79 cents, effective October 12. The Texas Co. schedule in North and Central Texas, same as Magnolia's except that it stops at 40 degrees and over at $1.03, effective October 12. Gulf Refining Co. same as the Texas Co., effective October 13. Sinclair Prairie Oil Marketing Co., in Mexia and North Central Texas, below 29 degrees, 76 cents, with 2 cents added for each degree up to and including 40 and over at $1, effective October 11. Stanolind Oil Purchasing Co. schedule started at below 29 degrees at 79 cents with a top of $1.03 for 40 degrees and over, effective October 11, but was revised on October 17 to read below 21 degrees, 60, cents, with a 2-cent spread to 40 degrees and over at $1.

Column 4—Standard Oil Co. of Louisiana, effective October 5, 1938. Met by Gulf Refining Co. October 13; met by Texas Co. October 12.

Column 5—Humble Oil & Refining Co., October 11, 1938.

Column 6—Humble Oil & Refining Co., effective October 11, 1938. Met by Sinclair Prairie Oil Marketing Co., stopping at 40 degrees at 96 cents, October 11. Texas Co. quotes "Panhandle sweet crude," beginning with 34-34.9 degrees, at 84 cents, with 2-cent spread to 40 and over at 96 cents, and "Panhandle sour crude," 79 cents for 34-34.9 degrees, with a top of 91 cents for 40 degrees and over, effective October 12. Magnolia Petroleum Co. met Humble prices throughout, effective October 12. Gulf Refining Co. quotes "Panhandle sweet crude" at below 29 degrees, 72 cents with a 2-cent spread, and a top price of 96 cents for 40 degrees and above, and "Panhandle sour crude" below 29 degrees, 67 cents, with a top of 91 cents for 40 degrees and above. effective October 13. Phillips Petroleum Co. schedule for sweet crude in the Gray, Carson and Hutchinson counties, starts at below 29 degrees, 64 cents, with a spread of 2 cents up to 88 cents for 40 degrees and over, effective October 12.

Column 7—Humble Oil & Refining Co., effective October 11, 1938. Met by Sinclair Prairie Oil Marketing Co., stopping at 40 degrees and over at 91 cents. Texas Co. quotes "Panhandle sweet crude" at 34-34.9 degrees, 84 cents, with a top of 96 cents for 40 gravity, and "Panhandle sour crude" at 34-34.9 degrees, 79 cents, with a top of 91 cents for 40 degrees and over, effective October 12. Gulf Refining Co. quotes "Panhandle sweet crude" at below 29 degrees, 72 cents, with a top of 96 cents for 40 degrees and over and "Panhandle sour crude" at below 29 degrees, 67 cents, with a top of 91 cents for 40 degrees and above, effective October 13. Phillips Petroleum Co. schedule for sour crude in Carson, Moore and Hutchinson counties, starts at below 29 degrees at 59 cents, with 2-cent spread up to 83 cents for 40 degrees and over, effective October 12.

Column 8—Humble Oil & Refining Co., effective October 11, 1938. Magnolia Petroleum Co., in Tomball, effective October 12.

Column 9—Humble Oil & Refining Co., effective October 11, 1938. The Texas Co. schedule starts below 26 degrees, 65 cents, and ends at 36 degrees and over at 87 cents, effective October 12. Gulf Refining Co. starts at below 26 degrees at 65 cents and ends at 40 degrees and over at 95 cents, effective October 13. Magnolia Petroleum Co. schedule starts below 25 degrees, 63 cents, and ends at 40 degrees and above at 95 cents, effective October 12. Sinclair Prairie Oil Marketing Co. schedule same as that of Magnolia, effective October 11. Stanolind Oil Purchasing Co. schedule same as that of Humble, effective October 11. Stanolind Oil & Gas Co. (Winkler County) starts at below 26 degrees, 65 cents, with a 2-cent spread, and a top of 95 cents for 40 degrees and above, effective October 11.

Column 10—Continental Oil Co., effective October 11, 1938.

Column 11—Humble Oil & Refining Co., effective October 11, 1938. Met by Gulf Refining Co. in Anahuac, but stopping at 40 and above at $1.23, effective October 12.

Column 12—Humble Oil & Refining Co., effective October 11, 1938. Met by the Texas Co. starting at below 21 degrees at 81 cents and stopping at 28 and above at $1.04.

Column 13—Humble Oil & Refining Co. in Mirando, effective October 11, 1938. The Texas Co. schedule in Mirando and Duval starts at below 21 degrees, 77 cents, with 3-cent spread to 28-28.9 degrees at 99 cents.

Column 14—Posted by Humble Oil & Refining Co., effective October 11, 1938. The Texas Co. schedule in coastal Texas and Louisiana, starts at below 21 degrees, 82 cents, with 3-cent differential up to 26-26.9 at $1 and then a 2-cent differential to top of $1.16 for 34 degrees and above, effective October 12. Gulf Refining Co. schedule on Louisiana Gulf Coast starts at below 18 gravity, 76 cents, with 2-cent spread to 20-20.9 degrees at 82 cents, then a 3-cent spread to 26-26.9 degrees at $1, then a 2-cent spread to a top of $1.16 for 34 degrees and over, effective October 12. Sun Oil Co. met Humble prices October 13, stopping at 34 degrees and over at $1.16.

Column 15—Magnolia Petroleum Co., effective October 12, 1938.

Column 16—Stanolind Oil & Gas Co. in West Beaumont, effective October 11, 1938, and Magnolia Petroleum Co. in Beaumont field, effective October 12.

Column 17—Magnolia Petroleum Co., effective October 12, 1938. Column 18—Continental Oil Co., effective October 11, 1938. Column 19—Shell Petroleum Corp., October 11, 1938.

Gulf Coast

Conroe, Tex. (Oct. 11, 1938)* $1.27
Black Bayou and White Castle, La. (Oct. 11, 1938)† .....See note below
Gibson, La. (Oct. 11, 1938)† 1.04
Garden Island, La. (Oct. 12, 1938)‡ 1.24
Lafitte, La. (Oct. 12, 1938)‡ 1.04
Cleveland, Tex. (Oct. 12, 1938)¶ ... 1.14
Hardin, Tex. (Oct. 12, 1938)¶ 1.02
Tepetate, La. (Oct. 11, 1938)§ 1.03
Villa Platte, La. (Oct. 11, 1938)§ .. 1.03
Abbeville, La. (Oct. 11, 1938)§
See note below
Bosco, La. (Oct. 13, 1938)¶ 1.02
Creole, La. (Oct. 12, 1938)¶ ..... .96
Gueydan, Sweet Lake and Louise, La. (Oct. 13, 1938)¶ .....See note below
Vinton, Edgerly, Starks, Hackberry, Timbalier Bay, Quarantine Bay, and Grand Bay, La. (Oct. 13, 1938)** ....
Long Lake, Tex. (Oct. 13, 1938)** .. 1.08
Segno and Wing (Oct. 13, 1938)**..
See note below
Livingston (Oct. 11, 1938)† 1.10
Gibson, La. (Oct. 11, 1938)† 1.04

*Humble Oil & Refining Co. †Shell Petroleum Corp. ‡The Texas Co. §Continental Oil Co. ¶Magnolia Petroleum Co. ‖Pure Oil Co. **Gulf Refining Co.

Black Bayou, etc., starts at below 20 degrees at 79 cents; 20-20.9, 81 cents; 21-21.9, 83 cents, then a 3-cent spread to 26-26.9 degrees, 98 cents, and 27 degrees and over $1. Abbeville starts at below 36 degrees, $1.01, 2-cent spread to 40 degrees and over at $1.11. Gueydan, etc., starts at below 20 degrees, 79 cents, 3-cent spread to 26-26.9 degrees at $1, and 2-cent spread to 40 degrees and over at $1.28. Segno and Wing take Gulf Refining Co.'s Gulf Coast prices. Vinton, Edgerly, etc., schedule starts at below 18 gravity, 76 cents, 2-cent spread to 20-20.9 at 82 cents; then a 3-cent spread to 26-26.9 at $1; then a 2-cent spread to 34 degrees and over at $1.16.

Southwest Texas

Salt Flat, Darst Creek, Hilbig, Carroll, Clark and Zoboroski (Oct. 11, 1938)* ..... $ .96
Pettus (Oct. 11, 1938)* 1.29
Flour Bluff (Oct. 11, 1938)* 1.27
Darst Creek (Oct. 12, 1938)† ..... .96
Darst Creek and Bruner (Oct. 13, 1938)‡ ..... .96
Luling (Oct. 12, 1938)† ..... .87
Lytton Springs (Oct. 12, 1938)† ... .99
Mirando (Oct. 12, 1938)†
Government Wells (Oct. 13, 1938)
See note below

*Humble Oil & Refining Co. †Magnolia Petroleum Co. Pettus price adopted by Atlantic Crude Oil Purchasing Co. ‡Gulf Refining Co.

Government Wells posted by Sun Oil Co. starts at 20 gravity, 77 cents, 3-cent spread to 24-24.9 at 89 cents.

North Louisiana and Arkansas

Smackover, Ark. (Oct. 5, 1938)* ... $ .73
Buckner, Magnolia and Village, Ark. (Oct. 5, 1938)* .....See note below
Schuler, Jones sand .....See note below
Tullos and Urania ..... .89
El Dorado east field ....
Lisbon, La. (Sept. 19, 1938) .....
See note below

*Smackover posted by Standard Oil Co. of Louisiana, October 5, 1938; by Magnolia Petroleum Co., October 12; by Gulf Refining Co., October 13; McMillan Refining Co. and Cross Refining Co. met price. Tullos and Urania posted by Hunt Oil Co. and Arkansas Fuel Oil Co.

Schuler Jones sand schedule starts at below 25 degrees, 66 cents, with 2-cent spread to 40 and over at 98 cents; by Lion Oil Refining Co. on October 5, 1938; Schuler light Morgan sand crude takes North Louisiana gravity scale along with El Dorado and Champagnolle; by Lion Oil Refining Co., October 5: Buckner, Magnolia and Village schedules posted by Standard Oil Co. of Louisiana and Lion Oil Refining Co. on October 5; quote same prices as for Schuler Jones sand crude.

Middle Western States

OHIO OIL CO.
(Effective October 13, 1938)

Lima, Ohio ..... $ .90
Illinois old fields 1.05
Illinois basin 1.15
Princeton, Ind. 1.05
Western Kentucky 1.10
Greendale, Porter and Crystal, Mich. (Oct. 13, 1938)* ..... .92½
Buckeye, Bentley, Edenville, Beaverton, Mich. (Oct. 13, 1938)* ... .90
Freeman, Mich. (Oct. 13, 1938)* ... .87
West Branch and Arenac, Mich. (Oct. 13, 1938)* ..... .74
Muskegon 1.00
Eastern Kentucky:
Big Sandy River (Oct. 1, 1938)† 1.22
Kentucky River (Oct. 1, 1938)† 1.30

*Simrall Corp. †Ashland Refining Co.

Rocky Mountain States

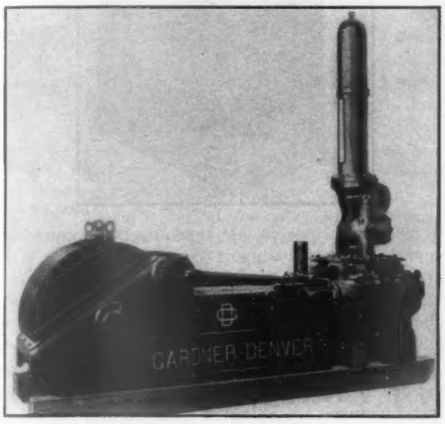
Dry Creek, Wyo. (Oct. 11, 1938)* $ .92
Elk Basin, Wyo. (Oct. 11, 1938)*† .90
Grass Creek, light, Wyo. (Oct. 11, 1938)*† ..... .90
Grass Creek, heavy (Oct. 11, 1938)† .40
Lance Creek, Wyo. (Oct. 11, 1938)* .77
Rock Creek, Wyo. (Oct. 11, 1938)* 1.00
Iles, light, Colo. (Oct. 11, 1938)† .98

(Continued on Page 271)

New or Improved Equipment

Gardner-Denver Power Pump for Slush Service Offered

The 7¼ x 12 FX power pump for slush service has been announced by Gardner-Denver Co., Quincy, Ill. The pump frame is of one-piece semi-



steel casting with integral crosshead-guides and main and jackshaft bearing supports, to insure alignment. Reinforcing ribs are placed where stresses are greatest. Two-piece piston-rod construction permits liners, pistons and rods to be changed without opening the power end.

The pinion-shaft, with extensions on both sides, is designed to transmit a maximum of 150 horsepower through the continuous-tooth herringbone pinion and main gear. The pinion is of forged alloy steel and the main gear is of alloy iron. Connecting-rods are of heat-treated alloy steel with split-type Premier lead-bronze renewable liners for eccentrics.

Automatic flood lubrication is used. Oil is contained in the reservoir in the main crankcase, the main gear being partly submerged. The fluid end is of the divided cylinder valve-pot type and is cast of a special alloy iron mixture developed by the company especially for mudpump service. Liners are of the removable type. Fluid pistons will be furnished in the type best suited to the service conditions of the specific location. Piston-rods are of special alloy metal. Duo-seat top- and bottom-guided type fluid valves are used. Tightness is obtained by the combination of steel and rubber seats.

The equipment includes the surge-chamber and a complete set of necessary special wrenches. Steel skids, liner-pullers and seat-pullers are not furnished as standard equipment.

Here and There With Men Who Manufacture Equipment

Grant Oil Tool Co., Los Angeles, Calif., has appointed Lloyd G. Ensign, 30 Rockefeller Plaza, New York, to act as its export sales representative. Mr. Ensign for 17 years was identified with oil exploration and operation in Trinidad and Venezuela. Before organizing his own export sales offices in New York, he was vice president of the Petroleum Machinery Corp.

In the contest sponsored by the James F. Lincoln Arc Welding Foundation, participated in by leading engineers throughout the world, George Heinish, chief engineer, and W. S. Riley, associate engineer of the Star Drilling Machine Co., Akron, Ohio, were given an award of the third prize in the petroleum division for their paper on the advanced welding methods used in the construction of the new No. 75 Spudrill.

John Zink, owner of John Zink Burners, Tulsa, has removed the company's New York offices to 342 Madison Avenue. J. Arthur Moore, formerly assistant to T. E. Ward, president of Oilfield Equipment Co., is in charge of the New York office.

J. B. McArthur, formerly with the Royal Manufacturing Co., Tulsa, has joined the sales organization of Fort Worth Structural Steel Co., Fort Worth, Tex. He is handling the sale of Refinite portable oil-field water-softeners in the Mid-Continent area.

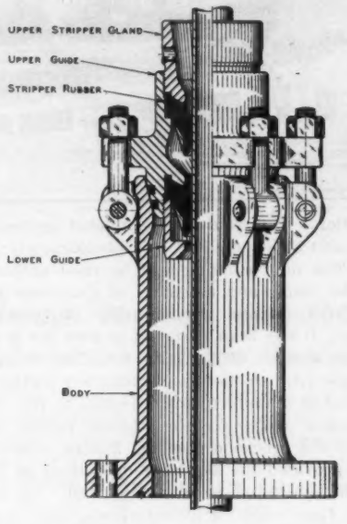
General Electric's sixtieth year was observed recently in Schenectady, N. Y., when the Chamber of Commerce presented the company with a bronze plaque, commemorating the steps leading to the formation of the company. The plaque was accepted by Gerard Swope, president.

McMurray Manager at Pampa

The Gilmore Wire Rope Division of the Jones & Laughlin Steel Corp., with executive offices at Muncy, Pa., has appointed Roy McMurray, Pampa, Tex., as district manager for the Panhandle and North Texas areas. Mr. McMurray is well known in the supply and equipment department of the oil country having spent 20 years in the territory mentioned and in Oklahoma. He was formerly with the Williamsport Wire Rope Co., and has spent the last eight years in the Panhandle region.

National Device Provides Safe Method of Running Tubing

With the National Type AH-2 stripper attachment, recently placed on the market, collared tub-



ing can be run in the well under pressure. The flexible stripper rubber is made to seal off the pipe and couplings effectively at all times. Ribbed construction enables the rubber to stretch around the couplings without damage and to withstand high well-pressures.

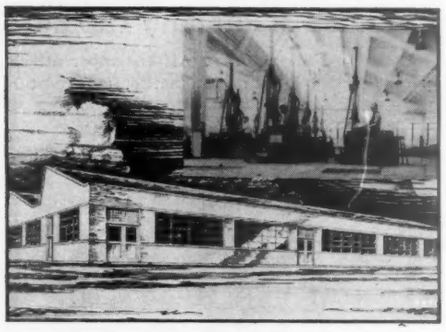
Upper and lower guides, which serve to center the couplings, protect the stripper rubbers, minimizing the danger of tearing. The guides and rubbers are assembled in a unit for conveniently attaching to the body. When used with a gate-valve and a ram-type preventer on wells equipped with National flanged tubing-heads, the Type AH-2 stripper attachment is said to offer a particularly safe and convenient means of running tubing.

REPUBLIC RUBBER SALESMEN HOLD ANNUAL MEETING

The annual conference of the sales organization of the Republic Rubber Division, Lee Rubber & Tire Corp., was held recently at the home office in Youngstown, Ohio. Interesting discussions dealt with new products, improvement in standard lines and with sales and sales promotional matters. Optimism concerning business conditions was expressed by representatives from all sections.

New Modern Building to Care for Cummins Engine Growth

Cummins Engine Co., Columbus, Ind., builder of automotive, industrial, and marine Diesel engines, expects its sales in 1939 to double this year's, which will be larger than those in 1937. The needed expansion of production facilities is being provided by a new building under construction. It is said the completed project will represent an expenditure of approximately $400,000. The new building will be used exclusively for the finish and assembly of Cummins Diesel fuel injectors and the assembly of Diesel fuel pumps. It has been designed to give the greatest possible control of dust and dirt. The machinery selected will enable line production methods to be used in manufacturing injectors to the closest tolerances and make the highest degree of accuracy and precision possible. Special rooms have been provided for assembly operations in which all air is filtered to eliminate dust. No fitting tools, files, vises, grinding-wheels, etc., will be allowed in these rooms, only the few tools needed to assemble the pressure-washed parts into complete units.



The all-welded rigid frame design of the building differs from conventional saw-tooth construction in that diagonal steel members have been eliminated. Two aisles each 40 feet in width will run the overall length of the building. There will be a maximum overhead clearance of 23 feet in each. Two side walls are of modern face brick. Two are of tile, in anticipation of expansion.

Power will be generated by a 500-horsepower 12-cylinder Cummins Diesel engine. Exhaust gas and cooling water from the engine will be reclaimed and used in heating the building. Overhead unit heaters will be used to maintain comfortable working conditions in the coldest weather. Lighting of modern high intensity will be provided.

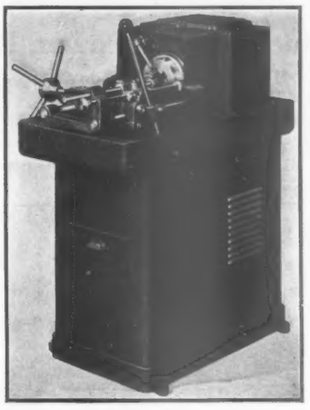
New Portable Air-Compressor Designed for Special Field

To fill requirements of a special field, Worthington Pump and Machinery Corp., of Harrison, N. J., has developed a portable air compressor with power take-off drive. Consisting essentially of a Worthington compressor driven through a Worthington Multi-V-Drive by a Hercules drive unit installed between the truck transmission and the front universal joint of the propeller-shaft, the new unit combines maximum portability with minimum truck payload space.

The compressor is the three-cylinder two-stage radial air-cooled type used on the standard Worthington portable mountings, and includes modern features of construction, including the improved feather valve, ring-type fins, large sectional-type intercooler, articulated connecting-rods, force-feed lubrication, and bypass unloading.

Rapiduction Junior Announced by Oster Manufacturing Co.

Oster Manufacturing Co., Cleveland, Ohio, has added a new bolt machine, the "Rapiduction Junior," to its line of threading equipment. Made



in two sizes, the No. 541 machine has a capacity covering all sizes up to 1¼-inch and the No. 542 up to 2½-inch. When stripped of diehead and vise-carriage, the machines can be adapted to chamfering, drilling, reaming, boring, tapping, and other jobs.

The machines are powered by constant-speed motors of 2 horsepower and 1,800 r.p.m. and speed changes are obtained with pick-off sheaves. The drive from motor to machine is through V belts. Eight spindle speeds are obtainable from 27 to 386 r.p.m. The final drive is by triple-thread worm, of hardened and ground steel, and running in antifriction bearings. This drives a bronze worm gear mounted on the spindle, which also runs in antifriction bearings.

The vise is of the open type, operated by a hand-wheel conveniently located at the operator's left hand. The vise jaws are of hardened steel, one serrated and one smooth for quick centering of the work. The jaws are adjustable both vertically and horizontally to maintain perfect alignment with diehead. The vise carriage is substantially constructed and mounted on two 1¼-inch steel studs positioned parallel to the bed of the machine and has a travel of 10 inches.

The diehead is of the rotary type, automatic, quick-opening and is fully adjustable for oversize or undersize threads. An adjustable, external tripping device can be set to open the head when the thread has reached any desired length.

After the thread has been cut and the head opened, it is automatically reset to size by returning the vise-carriage to its original position.

OIL HISTORY REFLECTED IN PIONEER ENGINE COMPANY

The colorful history of the oil industry is reflected in that of many of its pioneer companies, such as Ajax Iron Works, which is commemorating 60 years of steam drilling engine manufacture with an interesting four-page bulletin. Begun in Corry, Pa., in 1877, by a partnership of C. G. Harmon, G. H. Gibbs, F. L. Bliss, and C. H. Bagley, the manufacture of the new Ajax steam engine was conducted in a specially built 50 by 120-foot two-story building, with the second story occupied by the Harmon Opera House. One or another of the partners from time to time acted as manager of the theater.

Competition was bitter, the bottom fell out of prices in the oil industry, and when Mr. Bliss invented and patented his rigged reverse, by which action of the link was controlled by a line of small gas-pipe running to the derrick, other engine manufacturers appropriated it. Several hard years of lawsuits elapsed before the infant company derived any benefits from the invention, but after a fight which ended in the Supreme Court, the partners were victorious. An excursion in the grand manner to Niagara Falls celebrated the event. A special train was chartered for all employes and their families, and the jubilation was immense.

From that time on the fortunes of the company took an upward turn. Having begun with the manufacture of an 8 x 12 engine of 12 horsepower (ample for the shallow wells then drilled), the concern progressed steadily to larger engines, ever more finely made; to interchangeable parts, and to methods in advance of the times.

In 1892 the company was incorporated under its present title, and in 1909 the National Supply Co. became exclusive sales representative. In 1920 the introduction of rotary drilling called for more powerful engines. Ajax responded with the Ideal-Ajax twin engine.

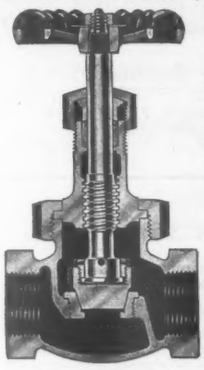
Many of the early Ajax engines are still in daily service, quaint in appearance beside the later products, but proving their sound and honest construction. Today, Ajax steam drilling engines are found in every oil field.

Rex Parks Joins Patterson-Ballagh

Patterson-Ballagh Corp. has appointed Rex Parks assistant to J. M. "Skeet" O'Melveny, sales manager in the Gulf Coast and Mid-Continent areas. Mr. Parks has had several years' experience in both the drilling and supply ends of the oil business. He has been a driller for Loffland Brothers in Kansas and the Gulf Coast, and he was connected with the J. E. Mabee Drilling Co. for several years as roughneck and driller. He joined the Bovaird Supply Co. as field salesman in Oklahoma, later going with the Chicago Pneumatic Tool Co. as district manager. He recently left the Green Head Bit & Supply Co. to join Patterson-Ballagh. Mr. Parks' headquarters will be in Houston, Tex., and he will cover the Gulf Coast and Mid-Continent.

Ohio Injector Introducing New Line of Union Bonnet Valves

Ohio Injector Co., Wadsworth, Ohio, has augmented its line of globe and angle inserted bonnet valves with a series of union bonnet valves, which are said to represent an advance in valve design and construction. The valve illustrated is Figure 558 union bonnet bronze valve for 200 pounds S.W.P., equipped with a 30-degree plug seat and disc of "Ohista" metal, an O.I.C. development. The seats and discs are 500-550 Brinell. "Ohista" metal is said to retain its hardness at high temperature, and to resist wear, erosion, corrosion, and galling. Foreign substances in the line, such as boiler scale and metal cuttings, are crushed without marring the seat or disc.



The new series includes a union bonnet bronze valve globe Figure 552, angle 553, for 200 pounds S.W.P., equipped with a plug seat and disc of "Ohiko" metal for 300-350 Brinell, and a spherical type globe Figure 526, angle 527, horizontal check Figure 532, and angle check 533 union bonnet bronze valves for 200 pounds S.W.P. with renewable seats and discs of "Ohiko" metal for 300-350 Brinell. All parts of the above valves interchange, reducing the stock of repair parts.

McGovern Chicago Manager

Lummus Co. has opened a Chicago office at 600 South Michigan Avenue, in charge of F. J. McGovern. Mr. McGovern started in the oil business in Tampico, Mexico, in 1920 and has had wide engineering experience. He has been in the service of Lummus since 1933.

Manhattan Rubber's Forty-fifth Anniversary Is Celebrated

The forty-fifth anniversary of the Manhattan Rubber Manufacturing Co., now the Manhattan Rubber Manufacturing Division of Raybestos-Manhattan, Inc., of Passaic, N. J., was observed recently. Two months after the foundation of the company, manufacturing operations were started, January 1, 1894, in one small building with a crew of 40 men.

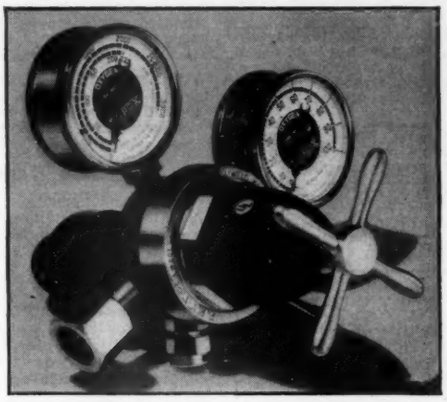
TOWNSEND

Frank Cazenove Jones, the first president, was forced to retire in 1903 because of ill health and he was succeeded by Col. Arthur F. Townsend, who served as president for 26 years up to the merger in 1929 which formed Raybestos-Manhattan, Inc. Since then Colonel Townsend has been chairman of the board of Raybestos-Manhattan, Inc., and general manager of the Manhattan division. Colonel Townsend is the American member of the Advisory Panel of the International Rubber Regulations Committee, which deals with the world's supply of crude rubber.

Manhattan was one of the pioneer rubber manufacturers to grow plantation rubber. Twenty-eight years ago the company opened up a tract in the jungles of Java in the Netherlands East Indies. From this plantation Manhattan obtains its crude rubber. The company employs approximately 3,000 persons in a plant that covers 800,000 square feet of floor space. Auxiliary plants have been established at Whippany, N. J.; Neenah, Wis., and North Charleston, S. C.

Three Regulators for Welding and Cutting Offered by Linde

The Linde Air Products Co., unit of Union Carbide & Carbon Corp., announces three new regulators: Purox oxygen regulator Type R-201 (for ordinary welding and light cutting), Purox oxygen regulator Type R-202 (for heavy-duty cutting), and Purox acetylene regulator, Type R-203.

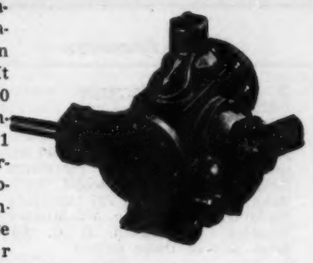


All three utilize the principle of two-stage regulation. A fixed "first stage" reduces the pressure of oxygen or acetylene from cylinder pressure to a moderate figure, below which it is regulated by the variable second stage of regulation. Stem-type valve mechanisms insure a uniform flow of oxygen and acetylene at the lower pressures at which the gases are used and in quantities sufficient for practically all welding and cutting operations.

The Monel metal valve-stems are distinct from the diaphragms, to eliminate the possibility of stem distortion due to diaphragm pull caused by leakage. Accurately machined guides assure correct alignment of the stems. Heavy valve closing springs give positive seating action. The Purox oxygen regulator Type R-201, shown in the illustration, is for ordinary welding and light cutting.

New Pump Has High Capacity in Relation to Its Weight

Granberg Equipment, Inc., 4068 Holden Street, Oakland, Calif., announces the addition of a 3-inch Granco pump to its line. This new unit is said to have unusually high capacity in relation to its weight. It delivers 300 gallons per minute, weighs 171 pounds and operates at 600 revolutions per minute. The exclusive Granberg rotor gives the highest dry suction, and the flow is said to be smooth and nonpulsating. The outboard bearing and silent relief valve are built as integral parts. The pump is bronze-fitted, has 3-inch flanged ports and operates in either direction. Tank truck manufacturers and operators are expected to find this unit a help in speeding up unloading time, decreasing dead weight and saving on operating costs.



Bulletins, Booklets and Other Literature for the Trade

"Remote Measurement and Control" is a seven-page booklet published by the Foxboro Co., Foxboro, Mass. It describes a new Foxboro pneumatic transmission system for remote measurement and control of flow, temperature, level and pressure.

Elgin Softener Corp., Elgin, Ill., has issued a bulletin, No. 510, on continuous blowdown systems for steam boiler plants. The need for such systems is illustrated by typical plant studies with useful charts and tables.

A 40-page bulletin on Type S Diesel engines has been published by Ingersoll-Rand, 11 Broadway, New York. This machine is a heavy-duty, continuous-service, compact engine for stationary or marine-electric application.

A book just published by the Federal-Mogul Corp., Detroit, Mich., illustrates and describes the various types of engine bearings, bearing liners and bushings in general use, the newest types now coming into wider use, and the methods of design and manufacture.

NEW BUILDING EXTENDS BAROID'S ANALYSIS FACILITIES

Construction of a new laboratory building adjoining its general plant at 837 Jackson Street, Los Angeles, Calif., affords the Baroid Sales Department opportunity to further its research and development on drilling fluids. The addition includes a research laboratory, a mechanical testing laboratory, a testing equipment display-room and it houses various departmental offices, besides a mud-sample room, duplicating-room and photographic laboratory. The research laboratory is complete in every detail for analytical and development work.

In the mechanical laboratory equipment designed to simulate actual conditions as closely as possible has been installed. Here all drilling muds are given exhaustive tests so that the mud engineer can be reasonably certain ahead of time what his mud will do. Baroid testing equipment affords the mud engineer an accurate check on his drilling mud right at the well. This fact has gained widespread recognition and the consequent demand for the testing equipment reached the point where it has necessitated the construction of a special display and stock room. Here are Baroid wall-building testers, Baroid mud-testing kits and mud-testing cabinets, viscosimeters, hydrometers, etc., all assembled and on display. A stock of all necessary equipment and parts is kept on hand for prompt filling of orders.

CLASSIFIED ADVERTISING

Patent Attorneys

JACK A. SCHLEY
PATENT LAWYER
Patents obtained — infringement practice in all Courts—oil field experience. 1807-11 Tower Petroleum Bldg., Dallas. 2014 Second Nat'l. Bank Bldg., Houston. 707 Insurance Building, San Antonio. 433 Munsey Building, Washington, D. C. Address any of these offices.

PATENTS — TRADE MARKS
All cases submitted given personal attention.
Form "Evidence of Conception" with instructions for use and "Schedule of Government and Attorneys' Fees—FREE
LANCASTER, ALLWINE & ROMMEL
Patent Law Offices
418 Bowen Bldg. Washington, D. C.

Leases and Drilling Blocks

LEASES—East Texas, La., South Ark. 30 acres up, dollar acre up. Owners—Address Attorney, Box 1122, Little Rock, Ark.

DRILLING deals wanted 50,000 acres Southern Illinois in and around production area. Elmer Gant, Anna, Illinois.

NEW MEXICO
State Oil and Gas Leases
Forty acres and multiples thereof at $6.00 to $30.00 per forty in the Hot Spots. Write for list. Twenty years in the business and not a complaint.
HARRY S. WRIGHT
New Mexico State Lessee, P. O. Box 347, Santa Fe, N. M., or P. O. Box 166, Council Bluffs, Iowa.

FOR SALE—Blocks of 100 to 10,000 acres 5 to 10 year term oil and gas leases located on structures near oil and pas producing wells. Two structures are geologically approved. Depth of drilling 450 to 900 feet. W. P. Harley, Bowling Green, Kentucky.

ILLINOIS 60,000 acres in and near production. Illinois Minerals Company, Cairo, Illinois.

NEW MEX. LEASES; Lea, Eddy, Chaves, Roosevelt, other SE Counties, 40,000 ac. blocks or spreads. Legitimate inquiries invited. GEO. M. COWELL CO., 412 W. 6th St., Los Angeles, California.

TEXAS leases in active counties cheap. Large or small tracts for brokers and salesmen only. Write H. H. WHITE, P.O. Box 674, San Antonio, Texas.

SOUTHEAST NEW MEXICO
Subdividing 80 acres in tracts as small as 1¼ acres. Buyers share in oil, gas, and minerals under entire 80. Write for literature.
HARRY S. WRIGHT
Box 347, Santa Fe, New Mexico.

ONLY 280 FEET to Oil sands. Four oil wells, cased, no tubing. One gas well. House, barn. 160 acres, 90 cultivated Some bottom, timber. All yours, land, mineral rights, for $5000. BUDDENBORG, Osawatomie, Kansas.

FOR SALE. 160 acre lease with two good gas wells just completed and on line in Eastern Kansas. Also, 80 acres offsetting. J. WILSON, Commercial Hotel, Paola, Kansas.

FOR SALE: 50 section, well equipped. East Central New Mexico Ranch. 34 sections patented. One half oil rights on 12 sections goes with sale. Will graze 1200 head of cattle. $6.00 per acre for patented land.
R. G. GRAY
O'Dell Hotel, Hot Springs, New Mexico.

WANTED TO BUY
Oil producing property. Partially developed preferred. Must be free from over-riding royalty. Size makes no difference. Write or wire
REYNOLDS SYNDICATE
703 City Bank Building
Lexington, Kentucky.

Leases and Drilling Blocks

10 ACRES Fee Land, Lea County, N. Mex., leased to Sun Oil Co. All Oil and Potash rights go with the warranty deed. Surrounded by Major Oil Companies. Inquiries solicited. Roy G. Barton, Hobbs, New Mexico.

PARTY now conducting special geophysical exploration surveys for oil promise is often in contact with drilling block opportunities, leases, production, royalties and sometimes capital for development where favorable conditions exist. P. O. Box 364, Fort Worth, Texas.

FOR LEASE—560 acres in Hillsborough County, Florida. This land has been tested and shows good prospects for oil and gas. Complete information furnished upon request. M. KOHN, 654 Euclid Avenue, Akron, Ohio.

S½ SE¼-19-24N-1W. Noble County, Okla. Near Phillips drilling well in 29. M. A. YOST, Billings, Oklahoma.

320 ACRES, Crane Co., Tex., Magnolia lease, cheap in fee. Address 415 Littlefield Building, Austin, Texas.

Wanted

WANTED
Producing properties—Will buy outright or develop for an interest. Send plat and complete information to Box J-621, The Oil and Gas Journal, Tulsa, Oklahoma.

If we do not maintain a classification exactly suited to the type of advertisement you wish to run, we shall be glad to create a fitting one.
Classified Department

Business Opportunities

HOT SPOT FOR SMALL REFINERY
Have the place for you, virgin territory, outlet for 200 to 500 bbl. plant. Sure crude supply, Wyoming field. Address
Box J-612
The Oil and Gas Journal, Tulsa, Okla.

"TRENTON (Missouri), in the heart of the leased area" (O.&G. J., 11-10) is the hot spot in the new North Central Missouri play. TRENTON provides adequate housing, low living cost, complete information, maps, supplies. Write or see Chamber of Commerce, TRENTON, Mo.

GEOLOGIST PARTNER, experience magnetometer for establishing magn. service. $500 required. Address Box J-640, The Oil and Gas Journal, Tulsa, Oklahoma.

Situations Wanted

GEOLOGIST-Engineer. A.B. in geology 1936. Graduate Asst. leading engineering school. Now employed in engineering capacity involving land and tax matters, Valuation, by Class 1 Railroad. Desire position where advancement is predicated on ability, not seniority. Address Box J-632, The Oil and Gas Journal, Tulsa, Okla.

WISH to act as sales representative in California for manufacturer of oil refinery equipment. Well qualified by engineering education and over ten years with Standard Oil to competently handle engineering sales work. Address Box J-630, The Oil and Gas Journal, Tulsa, Okla.

WANTED. Production Supt. and combination Tool pusher, 30 years' experience would like to make connection with Independent operator. Address Box J-641, The Oil and Gas Journal, Tulsa, Oklahoma.

Help Wanted

WANTED: Reliable and experienced Gas Lift Sales Engineer. Give complete personal record with references. Address Box J-611, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Capable "go getter" salesman who makes oil field trade regularly to handle oil field tool of great merit. Sell on sight. Must furnish references. Address:
HAROLD SMITH
509 Faurot Building, Lima, Ohio.

Incorporations

DELAWARE CHARTERS: Complete service $35. Sumbitted forms. Chas. G. Guyer, Inc., Wilmington, Delaware.

CHARTERS — Delaware best, quickest, cheapest, more liberal. Free forms. Colonial Charter Co., Wilmington, Del.

Legal Blanks

SINCE 1908 Burkhart's legal forms—serving Mid.-Cont. & Illinois oil fields. Free catalog & samples. Burkhart Ptg. & Sta. Co., 115 So. Cinn., Tulsa, Okla.

For Sale

FOR SALE—5 acres of mineral land in West Texas. Mrs. E. L. BAXTER, 125 Trenton Avenue, Findlay, Ohio.

Mailing Lists

ROYALTY Lists. Unit Owners Lists. Stockholders Lists. By states. Oil Industry Mailing List Co., Tulsa Loan Bldg., Tulsa, Oklahoma.

Royalties

ANDREW J. BARRETT
The Philtower
Tulsa, Oklahoma.

Brokers—Salesmen

Sell in the most active area in the United States—The Permian Basin of West Texas and Southeastern New Mexico. From the standpoint of royalty investors this area has much to offer. Can supply you with choice non-producing royalties located on geophysical highs. Also drilling blocks, close in acreage to production, or wildcat leases. I maintain my own field men who cover this area for me. All offerings meet the requirements of the Security and Exchange Commission. Inquiries invited.

B. D. BUCKLEY
Paul Brown Bldg., St. Louis, Mo.

Producing and Non-Producing
OIL ROYALTIES
Registered Dealers Only
GRIMES ROYALTY CO.
Hunt Bldg. Tulsa, Okla

PRODUCING OIL ROYALTIES
15 years of experience.
L. H. WITWER
703 Kennedy Bldg., Tulsa, Okla.

SOUTHEAST New Mexico—specializing in Oil Leases and Royalties; 18 years handling New Mexico Oil Properties. Inquiries solicited. Roy G. Barton, Hobbs, N. Mex.

For Sale—Maps

FREE COPY OIL AND GAS FIELD MAP
Of Texas, Eastern N. M., parts Southern Okla., SW Ark. and La. with every order for County Ownership or Oilfield Map. New map just out on Westmount Area in Lea Co., N. M.
Price $6.50 cloth $4.50 paper.
ZINGERY OIL MAP COMPANY
Fair Building Fort Worth, Texas

YOAKUM COUNTY, TEXAS
New 10,000-foot scale map including Wasson Pool, Gaines county, showing present fee and lease owners, wells and dry holes.
Paper, $1.25; cloth, $2
Same map 4000-foot scale, paper, $5; cloth, $8.
HEYDRICK MAPPING COMPANY
Wichita Falls, Texas.

UP-TO-DATE production maps of Kansas or Oklahoma. Oklahoma 4 by 6 ft. on paper $12—cloth $15. Kansas 4 by 8 ft. on paper $16—cloth $20. Also smaller sizes 28" by 36"—$4 and $6.
NICHOLS & PRATT MAP CO.
P. O. Box 2192
Tulsa, Okla.

Financing

CAPITAL SEEKERS—Put your project before 260 Key-Men. Cost trifling. Details free. AMSTER LEONARD, Fox Theater Building, Detroit, Michigan.

INQUIRIES SOLICITED FROM CORPORATIONS INTERESTED IN RAISING CAPITAL THROUGH THE MARKETING OF CORPORATE SECURITIES.
BROWN HARTWELL COMPANY
110 EAST 42 ST., NEW YORK.

OILMEN there are other ways to raise money than selling stock. Learn about revolutionary 60-month Plan launched by America's huge deposit-engorged banks and how to surround even new deals with fund protecting lender from loss. Bulletin $1.00. List of America's 64 leading underwriters who bought $300,000,000 securities last few months $3.00. JOHN MORRIS, 1040 South Paxon, Philadelphia, Pa.

CLASSIFIED DISPLAY RATES

Classified Display is set with a border and may be used in one or two column sizes.

1 Inch	*1 time*	*$5.00*
1 Inch	*13 times*	*4.50 per inch*
1 Inch	*26 times*	*4.00 per inch*
1 Inch	*52 times*	*3.50 per inch*

This space may be contracted for over a period of one year from the date of the first insertion and is PAYABLE IN ADVANCE, MONTHLY.

CLASSIFIED

Classified advertising rates: First insertion, 35 cents a line; each additional insertion, 25 cents a line, PAYABLE IN ADVANCE. Six words usually make a line. Count as a word each one-letter word and each group of figures. White-space computed at regular line rate. Allow two extra lines for blind ads. Ads of less than three lines not accepted. No formal acknowledgement is made, and proofs cannot be shown in advance of publication.

	1 time	2 times	3 times	4 times
3 Lines	*$1.05*	*$1.80*	*$2.55*	*$3.30*
4 Lines	*1.40*	*2.40*	*3.40*	*4.40*
5 Lines	*1.75*	*3.00*	*4.25*	*5.50*
6 Lines	*2.10*	*3.60*	*5.10*	*6.60*
7 Lines	*$2.45*	*$4.20*	*$5.95*	*$7.70*
8 Lines	*2.80*	*4.80*	*6.80*	*8.80*
9 Lines	*3.15*	*5.40*	*7.65*	*9.90*
10 Lines	*3.50*	*6.00*	*8.50*	*11.00*

We reserve the right to withhold all advertising of questionable character. To avoid delay be sure to send remittance with copy. We will set your ad in the smallest amount of space possible and refund all overpayments. One-time insertions will not be run until fully paid. Forms close MONDAY NOON before each issue date.

THE OIL AND GAS JOURNAL
Tulsa, Oklahoma

CLASSIFIED ADVERTISING

For Sale—Equipment

For Sale—Equipment

For Sale—Equipment

STEEL STORAGE TANKS—SPECIAL

150—80,000 Bbl. Cap. All Steel, Latest Type,
Quotations Reerected any location in the United States
Complete Stock all other size tanks
Write immediately for quotations.

SONKEN-GALAMBA SUPPLY COMPANY

W. C. Berry or H. J. Galamba
Riverview at Second
Kansas City, Kans.

J. O. Isaacks
Hays, Kansas

Robt. W. Duden
2100 S. Union
Tulsa, Oklahoma

FOR SALE—1 Model KS-6-DHK Cardwell Oilwell servicing winch unit, mounted on Mack Truck. Can be inspected O.C. garage. Operating condition now. I.T.I.O., Bartlesville, Okla.

ONE complete string steam rotary with rig, two 90 horse power boilers, in shape to drill immediately, priced $9500. One complete string steam rotary with rig, three 90 horse power boilers, complete with fishing tools and other extra equipment, in excellent shape to drill, priced $15,000. Rigs located on Tucker Lease, Haven, Kansas. For further information contact Vicking Drilling Company, c/o Yingling Chevrolet Co., Wichita, Kansas.

FOR SALE: At Oklahoma City 1—10,000 Barrel Parkersburg knocked down bolted steel tank. I.T.I.O., Bartlesville, Oklahoma.

OVER 100,000 FEET 10¾" O D

Forty pound used wrought Iron line pipe with threads and couplings. Cleaned. Located Walton and Greentown, Indiana. Exceptionally LOW PRICED. Wire or Write.

STANDARD OIL FIELD SUPPLY CO.
P.O. Box 863 Houston, Texas

SECTIONAL STEEL BUILDINGS FOR SALE: 1—30 x 10 x 60 standing; 1—20 x 8 x 128 K.D. Oklahoma City; 1—24 x 8 x 106 K.D. Seminole. Condition O.K. Inspection invited. I. T. I. O., Bartlesville.

FOR SALE
HOLLOW-BORED USED STEEL LOCOMOTIVE AXLES

Bore 3"; 6" to 12" dia., approximately 46" long.

Possible cheap attractive substitution for costly billet, bloom, tube, shafting, axle, rod, etc., steels.

Also SOLID LOCOMOTIVE AXLES and STEEL FREIGHT CAR AXLES from 3¼" to 6⅞" diameters.

Large stocks always available. Write for prices, analyses, sketches, etc.

IRON & STEEL PRODUCTS, INC.
Chicago (Hegewisch Sta.), Ill.
Anything containing IRON or STEEL

25 K.W. and 40 K.W. Gas Engines, 220 volts, D.C. Two 100 K.W. Gas Engine-Generator Sets, 220 volts, D.C. 7x6 Ingersoll-Rand ER-1 Air compressor. Six-inch Oster Pipe Threading Machine. Also large stock of lathes, pipe machines, milling machines, etc. Send for our list.

Terms to suit.

CINCINNATI MACHINERY & SUPPLY CO.
26 West 2nd St. Cincinnati, Ohio

REPRESSURING UNIT

1—80 H. P. Direct driven two stage Bessemer with 10½ x 20 and 5¼ x 20 compressor cylinders, for sale. OTHA H. GRIMES, Box 327, Tulsa, Oklahoma.

DISMANTLING GASOLINE PLANT

Engines, Compressors, Storage Tanks, Regulators, Meters, Pumps, Buildings, etc.

Will sell plant complete or individual items.

Also complete stock of Line Pipe and Casing on hand.

Wire, phone, write

PRODUCERS PIPE & SUPPLY CO.
Tulsa, Oklahoma
Box 1814 Phone 2-1188; L.D. 501

BIG BARGAIN

Air Compressor—10x5x10; 60-HP Oil Engine, Almost new. At Centralia, Ill.

P. O. Box 1052, St. Louis, Mo.

1—Gasoline powered rotary rig consisting of: 2—125 HP Waukesha engines with reduction gears, 1—Reverse clutch, 1—3 speed drawworks, 1—6x12 Gardner-Denver pump, 1—96' Emsco steel derrick, 1—17" Oil Well rotary, 1—48" Boykin traveling block, 1—Boykin crown block, 1—Steel tool house, 1—clothes house, 1—Kohler light plant with house, 1—100 bbl. water tank and 1,350' 4" drill pipe.

1—Portable Rig, Rig #447 complete with 180 HP Waukesha Hesselman engines, slush pump and all equipment including 3,200 feet 4½" pipe.

1—6,000 foot Diesel electrical-mechanical rig, complete and in excellent condition.

K. S. RICHARDS
P.O. Box 830 Phone 2-1161 Ft. Worth, Tex.

WHAT ABOUT YOUR DECEMBER 31st INVENTORY?

Will it reflect a lot of idle equipment—equipment that has served its usefulness to your company?

Cash buyers are looking for used equipment in good condition and will pay a fair price. Allow us to call attention to your idle pieces. Our publication, devoted to oil men, enables us to serve you more efficiently than any other medium.

A small ad in these columns will contact prospective buyers at a trivial cost.

Classified Department.

For Sale—Equipment

VIKING 4", 250# pressure rotary pump and Foote reducer ready for connection to engine. Like New $350.00. Worthington 4", 200# pressure rotary, only $275.00.
CORKEN
206 E. Grand, Oklahoma City, Okla.

FOR SALE: At our Oklahoma City Warehouse Model D48 Muskogee Iron Works long line well servicing unit powered by HXE Hercules engines mounted on No. 55 truck. I.T.I.O., Bartlesville, Oklahoma.

FOR SALE

1—Star Drilling Machine with 50 h.p. Hercules motor, all mounted on Caterpillar Traction. 20,000 feet 4" seamless drill pipe with tool joints to single. We have a complete line of casing, line pipe and drilling machinery. Also have racked in Kansas 25,000 feet 8" plain end line pipe suitable for high pressure gas or oil line. Wire, phone, or write to

Louisiana Iron & Supply Co.
Shreveport, Louisiana

FOR SALE. One ten thousand watt Kohler light plant—good shape—new battery. WALKER HOTEL, Hobbs, New Mexico.

Equipment Wanted

WANTED: 2000—9⅝" OD Field End Colona Casing Protectors. I.T.I.O. Purchasing Dept., Bartlesville, Oklahoma.

WANT 20 to 24 foot all steel band wheel. Also 35 H.P. Superior. Give condition, location and price. Box 57, Chetopa, Kans.

Survey Service

THE DOWSING METHOD for locating oil structures, faults, and treacherous areas, operates on the principle of vibratory response to emanations from petroliferous sub-strata. Our WATSON No. 2, pioneer well of the Wilmington, Calif., field was located by this method and all my personally owned production. 15 years' experience. The physico method may solve all your structural difficulties. Geo. Miller, 1548 Post Avenue, Torrance, California. Phone 983.

Oil Industry Printing

OIL FIELD LEGAL BLANKS
Leases, assignments, releases, township plat books, well records, etc. Request on your letterhead gets free catalog. Olde Press, 215 East Third St., Tulsa, Okla.

Manufacturer

Established Manufacturer of Oil Field Equipment with large plant and ten (10) stores in Mid-Continent and California Oil Field desires to manufacture patented items for use in pipe line pumping, production pumping, or drilling service. Address Box J-403, The Oil and Gas Journal, Tulsa, Okla.

Crude Oil Prices

(Continued from Page 266)

lles, heavy, Colo. (Oct. 11, 1938)† .92
Dutton Creek, Wyo. (Oct. 11, 1938)†
See note below
Frannie, light, Wyo. (Oct. 11, 1938)† .55
Frannie, heavy, Wyo. (Oct. 11, 1938)† .42
Hamilton dome, Wyo. (Oct. 11, 1938)† .35
Midway, Wyo. (Oct. 11, 1938)†
See note below
Salt Creek Tensleep crude, Wyo. (Oct. 11, 1938)† .646
Salt Creek (Oct. 11, 1938) See note below
Canon City, Colo. (Oct. 11, 1938)‡ .90
Florence, Colo. (Oct. 11, 1938)‡ .90
Cat Creek, Mont. (Oct. 11, 1938)‡ 1.10
Big Muddy, Wyo. (Oct. 11, 1938)‡ .98
Lance Creek, Wyo. (Oct. 11, 1938)‡ .77
Lea County, N. M.
See West Texas gravity schedule‡
Artesia, Jackson and Maljamar
See gravity table‡
Fort Collins and Wellington, Colo.
See gravity table‡
Eddy County, N. M. (October 11, 1938)¶ .77

*Ohio Oil Co. †Stanolind Oil & Gas Co. ‡Continental Oil Co. ¶Sinclair Prairie Oil Marketing Co.

Dutton Creek and Salt Creek Tensleep crude start at below 29 degrees, 86 cents, 2 cents spread to 40 and over at $1.10. Salt Creek crude excepting Tensleep, takes Standard Oil Co. of Indiana Oklahoma-Kansas prices. Stanolind Oil & Gas Co., effective October 11, discontinued posting prices in Greybull-Torchlight, Wyo., and Hogback and Hospah, N. M.

West Texas

See gravity table.
Pecos County (Oct. 11, 1938)* .... $ .78
Pecos shallow (Oct. 11, 1938)† .... .65

*Shell Petroleum Corp., Gulf Pipe Line Co. and Humble Oil & Refining Co. †Shell Petroleum Corp.

Eastern States

TIDE WATER ASSOCIATED OIL CO. and NEW YORK TRANSIT CO
(Effective September 1, 1938)
Bradford, Pa. $1.68
Allegany, N. Y. 1.68

SOUTH PENN OIL CO.
(Effective September 1, 1938)
Pennsylvania Grade Oil in National Transit Lines (Bradford field) .. $1.68
Pennsylvania Grade Oil in Southwest Pennsylvania Lines 1.34
Pennsylvania Grade Oil in Eureka Pipe Line lines 1.28
Pennsylvania Grade Oil in Buckeye Pipe Line lines 1.18
Corning Grade Oil in Buckeye Pipe Line Co. line (Oct. 18, 1938) .... .97

PENNZOIL CO.
Group A $1.61
Group B 1.60
Group C 1.59
Group D 1.58
Group E 1.56

PURE OIL CO.
(Effective September 1, 1938)
West Virginia $1.28

Canada

Ontario (Oct. 25, 1938)*
Petrolia $1.90
Oil Springs 1.97

TURNER VALLEY
(January 5, 1938, by Imperial Oil, Ltd.)
Clear naphtha and discolored naphtha, 65 gravity and higher $2.14
Discolored naphtha and crude oil, 40-40.9 gravity 1.14
Increasing 2 cents for each degree gravity with top price for 64-64.9 gravity 1.62
These prices f.o.b. producers field tankage.

*Imperial Oil, Ltd.

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